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BORDE'S HOISTING APPARATUS.

IT was in 1857, at the period at which the monumental houses along Joliette wharf, at Marseilles, were building, that Mr. Borde devised the hoisting apparatus that bears his name.

It was Mr. Borde's idea to do away with costly and cumbersome scaffoldings, and to take the stone from the pile and put it directly in place without rehandling, and as rapidly as possible. With this end in view, he had several types of apparatus constructed. Of these, his stationary one, which was designed to be placed in a court or any other central part of a building, consisted of a large stationary post with a jib, movable around a pivot fixed to the post by a collar. Ropes connected with the end of the jib permitted of giving the latter any desired inclination. Two pulleys, one at the head and the other at the base of the jib, received a wire cable actuated by a steam motor located at a distance. This was, as may be seen, nothing more than a simple crane.

The movable hoisting apparatus, on the contrary, consisted of a frame mounted upon a movable carriage (Figs. 5 and 6). This frame, which was formed of two vertical cheeks, with cross braces and horizontal ties, was, along with a motor, mounted upon a car that ran upon an iron track. At the center of this frame was situated a jib which moved in a vertical plane. As in the former case, the laying of the stones was done through the intermedium of an iron wire cable actuated by the motor.

Experience having shown Mr. Borde the necessity of improving his invention, he was soon led to get up a model, in which were found all the elements of the former system. But in this new device the jib was placed at the upper extremity of the frame, where it oscillated around a horizontal axis. In order to balance it well and render the maneuver of it easy, Borde prolonged it and made an oscillating lever of it. The pulleys and iron cables were retained, but the balance was maneuvered by acting upon one of its extremities through a cable actuated directly by the motor. As the balance had to be very strong, and yet very light, it was constructed in the form of a trussed beam, the trussing of which consisted of bars of iron. In 1867, a machine of this type (Figs. 1 and 2), having a balance 65 feet in length, was used in the construction of the Vaudeville Theater at Paris. In these figures, A represents the motor; B, the cheeks of the crane; C and D, the winches; E, the balance; F, the brake; H H, starting gear; I, transmission for moving the car; K, tension wire.

CONSTRUCTION OF A VIADUCT BY MEANS OF A BORDE HOISTING APPARATUS.

In June, 1884, during the construction of the Dombrif Viaduct, Mr. George Averly had a hoisting apparatus built after the Borde type for work on that structure. This apparatus (Figs. 7 and 8), which was placed upon a service bridge about 30 yards above the lowest part of the ravine, was capable of lifting a weight of 3,300 pounds and of laying stones 100 feet above the bridge. This apparatus differed but little from the types just mentioned, and the only thing peculiar about it was the balance. This latter, which was of iron, was parabolic in form and of rectangular section, and 72 feet in length. Seen from below, it was fusiform. Its motions were varied by hand, a brake being used for increasing the range, and a winch for decreasing the same. The load was raised by means of a winch.

At the Dombrif Viaduct, this crane did duty for five piers, on each of which there were four or five masons at work.—*Abstr. from Le Genie Civil.*

LUMBERMEN are scarce in Canada. Wages this season are $24 to $28 and "all found."

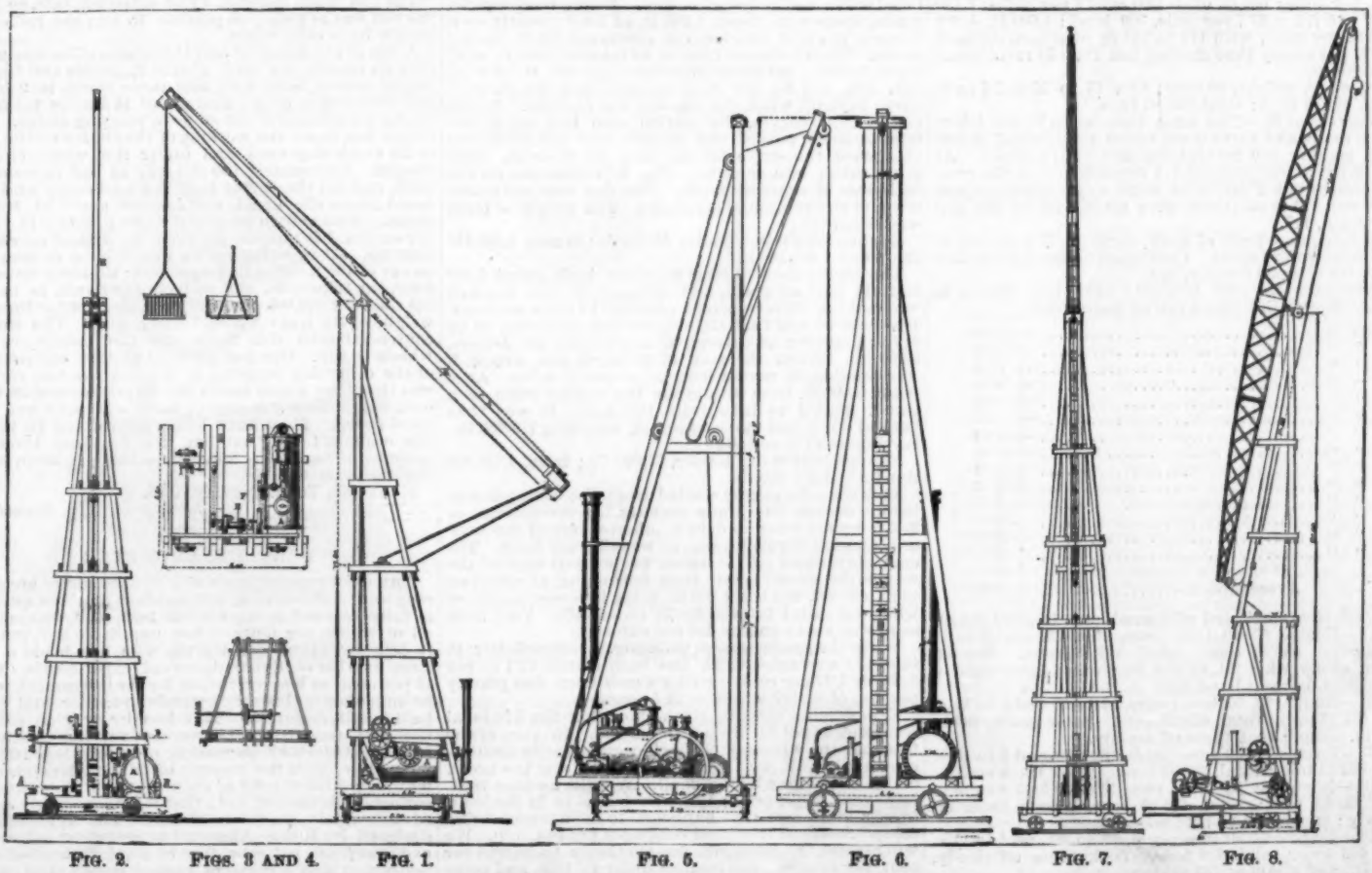


FIG. 2. FIGS. 3 AND 4. FIG. 1. FIG. 5. FIG. 6. FIG. 7. FIG. 8.

FIGS. 1 AND 2.—Lateral and Front Elevation of a Borde Hoisting Apparatus (Scale 0·01 m. per meter). FIG. 3.—Plan at the Height A B. FIG. 4.—Plan at the Height C D. FIGS. 5 AND 6.—Lateral and Front Elevations of a Borde Hoisting Apparatus (Scale 0·015 m. per meter). FIGS. 7 AND 8.—Front and Lateral Elevations of Mr. Averly's Modification of the Apparatus.

TESTS OF POWER OF LOCOMOTIVES.

By C. H. HUDSON, Member of the Western Society of Engineers.

AT the time of making the experiments to determine the frictional resistance of railway trains described in a recent paper, the writer also made some experiments to determine the power of a locomotive and also to ascertain what proportion of its weight upon the drivers could, under favorable circumstances, be utilized. Still later, in testing some newly arrived engines, he made other experiments bearing upon the same question. These are the subject of this paper:

The engine and cars in the first series of these experiments were the same described in a former paper (*Journal of the Association of Engineering Societies*, December, 1885), the same weights being used. As the description gives the weights in gross, it is not necessary to give the details again. It is proper, however, to say that the engine had cylinders 17 by 24 and 58 in. wheel.

Experiment 7.—Trial of power of engine on curve, being seven hundred feet of two degree curve and seven hundred feet of three degree, and upon a grade averaging 0·91 per 100 ft., or 48·05 ft. per mile. Track only in fair condition.

(A).—Engine 47, weight, 58 tons; cars, 1 to 30; weight, 726·2 tons; total, 784·2. Could not start them.

(B).—Engine 47, weight, 58 tons; cars, 6 to 30 = 25; weight 605·4 tons; total, 663·4 tons. Sarted them a car length; 133 lb. steam; no sand used.

(C).—Engine 47, weight, 58 tons; cars, 9 to 30 = 22; weight, 532·6 tons; total, 590·6 tons; 130 lb. steam; started easily.

(D).—Engine 47, weight, 58 tons; cars, 7 to 30 = 24; weight, 581·3 tons; total, 639·3 tons; moved off slowly.

(E).—Engine 47, weight, 58 tons; cars, 6 to 30 = 25; weight, 605·4 tons; total, 663·4 tons; 128 lb. steam; moved them 60 ft.

Experiment 23.—Trial of power of engine on 2° 30′ curve to right; grade from a point 100 ft. ahead of engine was as follows:

1·27	per 100 ft., elevation	0·021
1·17	" " " "	0·028
1·12	" " " "	0·025
0·95	" " " "	0·030
1·09	" " " "	0·023
1·20	" " " "	0·027
1·15	" " " "	0·023
1·10	" " " "	0·025
1·14	" " " "	0·024

Giving an average of + 1·13 per 100 ft. from rear end of train to a point 100 ft. ahead of engine. Track steel, in fair condition, ballasted with fine sand or gravel. Gauge open three-eighths to five-eighths of an inch.

(A).—Engine 63, 60 tons; cars, 16 to 30 and 11 to 15 = 20; 486·1 tons; total, 546·1 tons. 130 lb. steam; moved off, two or three miles per hour.

(B).—Engine 63, 60 tons; cars 16 to 30 and 10 to 15 = 21; 508 55 tons; total, 568·55 tons; started them all right.

(C).—Engine 63, 60 tons; cars, 16 to 30 and 9 to 15 = 22; 532·55 tons; total, 592·55 tons; moved them 100 ft.

(D).—Same number, back to old place. Started again and took them 200 ft. Then took slack, as they stood and took them off, but slowly.

For 200 ft. from place where grade is given it eases up a little, and then is again 1·10 per 100 ft. This train, 592·55 tons, was started on the 1·13 grade (59·66 ft. per mile), with 130 lb. steam; no sand used.

Experiment 24.—Engine 63 then took 25 cars over grades about as follows:

1,100 ft., slightly down or level. 1,100 ft. + 0·818 = 43·19 per mile; 600 ft. of + 1·00 = 52·8 per mile: 1,100 ft. of + 0·714 = 37·7 per mile, 300 level; 1,000 ft. + 0·9 = 47 52 per mile; with 110 to 120 lb. of steam, doing it easily, not at any time making less than 50 revolutions per minute.

Engine 63, weight, 60 tons: cars, 16 to 30 and 6 to 15 = 25; 602·85 tons; total, 662·85 tons.

Experiment 25.—The same train as in 24 was taken to the grade and curve upon which experiment 23 was tried, making 140 revolutions and 140 lb. steam. At end of curve was making 115 revolutions; at the commencement of a 3° curve the other way (a short tangent between), 120 revolutions were made, and at the end 95; steam, 115.

At commencement of next curve (6°, 52·8 grade), 48 revolutions were made. Continued on same grade and curve till stopped; steam, 130.

Experiment 26.—On tangent; same hill; grades as follows from point where tail of train stood:

100 ft.	+ 1·06
" "	+ 1·09
" "	+ 1·25
" "	+ 0·96
" "	+ 0·82
" "	+ 0·91
" "	+ 0·90
" "	+ 0·91
" "	+ 0·72
" "	+ 0·96
" "	+ 1·09
" "	+ 1·21
" "	+ 0·98*
" "	+ 1·13*
Average	+ 0·952

Track steel, ballasted with sand, and in good shape.

(A).—Engine 63, 60 tons; cars, 16 to 30 and 9 to 15 (inclusive), 532·55 tons; total, 592·55 tons. Started them easily with 131 to 135 lb. steam; light wind in front and on right hand side.

(B).—Engine 63, 60 tons; cars, 16 to 30 and 7 to 15 = 24; 581·25 tons; total, 641·25 tons. Same place; 130 to 135 lb. steam; took them off readily.

(C).—Engine 83, 60 tons; cars, 16 to 30 and 6 to 15 = 25; 606·45 tons; total, 666·45 tons. Took them easily.

(D).—Engine 63, 60 tons; cars, 16 to 30 and 5 to 15 = 26; 630·65 tons; total, 695·65 tons. Took them off slowly; steam, 130 to 133; no sand.

(E).—Engine 63, 60 tons; cars, 16 to 30 and 4 to 15 = 27; 656 tons; total, 716 tons. Took them off slowly, 150 ft., and steam at 135 at stop.

(F).—Engine 63, 60 tons; cars, 16 to 30 and 3 to 15 = 28; 675·85 tons; total, 735·85 tons; 130 lb. steam; took them off slowly.

(G).—Engine 63, 60 tons; cars, 1 to 30 (inclusive), 723·65 tons; total, 783·65 tons; 131 to 135 lb. steam; started them 30 or 40 ft.; tried a second time and took them 60 ft.; steam, 130 to 135.

(H).—Engine 63, 60 tons; cars, 16 to 30 and 2 to 15 = 29; 699·80 tons; total, 759·80 tons; steam, 133 to 135; took them 100 ft.

(I).—Engine 63, 60 tons; cars, 16 to 30 and 3 to 15 = 28; 675·85 tons; total, 735·85 tons; steam, 130 lb.; took them 15 car lengths, and until engine was 200 ft. upon the 6° curve; no sand; wheels did not slip; moved them at rate of two or three miles per hour.

Now, the power of engine 63, estimated by the usual formula, would be as follows:

$$\frac{17\times17\times24}{58} \times \text{steam pressure in cylinder} = 119{\cdot}59 \times \text{pressure in cylinder.}$$

The average grade was 0·952 = 50·27 ft. per mile.

The resistance due gravity would be 0·952 × 2,000 = 19·04 lb. per ton; resistances due other causes (exps. 8 to 22), 4·40 lb. per ton; total, 23·44 lb. per ton.

In the last case the weight moved was 735·85 tons, which, at 23·44 lb., gives a force of 17,616 lb. required to move it up that grade.

As 119 59 × cylinder pressure = force (power of engine), then force = cylinder pressure ÷ 119·59.

As force in this case is 17,616, we have:

$$\frac{17{,}616}{119{\cdot}59} = \text{cylinder pressure} = 144 \text{ lb.}$$

But as the steam pressure in the boiler is but 130 lb., it could not have been 144 in the cylinder. It might possibly have been 125 lb. At that figure we would have a theoretical force of 119·59 × 125 = 14,949 lb. Now, the actual resistance was 17,616 lb., or more than the theoretical power, 2,667 lb., or 18 per cent. above it.

There can be no doubt as to the effect of gravity, viz, 19·04 lb. per ton; this, for 735·85 tons, will give 14,010 lb., which would leave for other resistances, assuming the force of engine to be at 125 lb. in cylinders, 14,949 lb.; this would leave but 939 lb. for all other resistances, or, per ton moved, 1·27 lb.

Our other experiments prove that this cannot be correct; we must, therefore, conclude that the formula for estimating the power is not correct. If we now discard the weight of the engine and use only the weight of the train, we have moved 679·85 tons, which, at 23·44 lb. resistance per ton, gives 15,936 lb. as the force required to move it. If we now assume that at that slow speed the cylinder pressure was equal to that in the boiler (hardly probable), we will have the power of the engine, 119·55 × 130 = 15,547 lb., pretty nearly equal to the estimated force required to move the load aside from the engine. You will note that the force required to move the load, including the engine, is 43·5 per cent. of the weight on the drivers, comparing favorably with the experiments upon the Erie road many years ago, when one-third of such weight was utilized. In ordinary practice, however, but one-fifth is calculated upon as available.

Recently, for the purpose of testing a new engine of the Consolidation pattern, just received by the East Tennessee, Virginia, and Georgia Railroad, we weighed a train of thirty loads, caboose and private coach, and took it with the engine to a heavy grade about a mile long, averaging 67$\frac{1}{10}$ ft. per mile. The grade was not even, but undulating; some being more and some less than the average. In one place, 100 ft. were at the rate of 98 ft; another spot of 200 ft. at the rate of 91 ft., and, of course, to match it, other spots were less than the average. The rail was steel, fairly ballasted and surfaced only; not in first-class line. Before reaching the grade, there were about 1,000 ft. of level; mostly on a 3° curve to right, which curve continued 800 ft. up the grade. Then followed 1,600 ft. of tangent; 600 ft. of 6° curve to left; 100 ft. of 10° to left, and 900 ft. of 6° to left, followed by 400 ft. of tangent and 500 ft. of 4° curve to right, when the summit was reached. At the end of these curves, the section men had (as is frequently done) pushed the tangent into the curve and sharpened the curve for the first 100 ft. or so. This is not taken into account. The 10° curve was on the little spot of sharpest grade. The day was warm and dry and circumstances favorable. The weight of train was as follows:

Engine, 109,000 lb.; tender, 55,000 lb.; 32 cars, 1,453,160 lb.; total, 1 617,160 lb.

The engine stood at start at water tank about 1,500 ft. from foot of grade, and when grade was reached was making 120 revolutions, or about 18 miles per hour. It should be said that the engine had cylinders 20 by 24 in.; diameter of drivers, 59 in.; weight on drivers, 97,000 lb. When the spot of 10° curve was struck, it was running 50 revolutions, or about 7 miles. At a point 3,700 ft. from the grade the engine came to a stand, unable to take train through. It was then backed down and two cars set off, weighing 123,500 lb., leaving weights as follows:

Engine, 109,000 lb.; tender, 55,000 lb.; train, 1,329,660 lb.; total, 1,493,660 lb.

This time the engine started from the same place as before, struck the grade making 150 revolutions, or 22 3 miles per hour, and in 7 minutes turned the summit, making 30 revolutions, or 4·5 miles per hour. The engine averaged 145 lb. steam, was worked most of the way in the second notch from bottom, or at about an 18 in. cut-off, the last 1,200 ft. being in lowest notch, or what was called full stroke (22 in. cut-off). Very little sand was used; engine did not slip any.

While the grade was undulating, it seemed fair to take the average—which has been stated, 67·1 ft. per mile, or 1·27 per cent.—giving a resistance due gravity per ton of 0 0127 × 3000 = 25 4 pounds.

Experiments already given show that the frictional resistance is not far from 5 lb. per ton. In view of the fact that the wheels of the train were too wide (as hereafter explained), we think that that is not too great, and possibly may be too small. We will assume that, however. No special pains were taken to fix the bearings, a lot of cars that happened to be in transit being taken. Assumed frictional resistance per ton, 5 lb. We will assume the resistance due curvature to be 0 05 per cent. per degree. Authorities differ in this, and some go as low as 0·03 per cent.

The writer's observations have been that in equating grades, where he used 0·05 per cent. per degree, and widened the gauge, an engine that would move its train steadily on a given tangent grade would, on reaching a curve with grade equated at 0 05 per cent., "pick up" a little in speed, showing that the equation was a trifle above the necessities. This has been the experience of others. On the road where this experiment was tried, however, the gauge was not open at the curves—as it should have been—and, added to that, the wheels of many of the cars in the train were wide, only scant three-eighths of an inch clearance between the wheel and the rail; while the clearance should be three-fourths of an inch. In view of this it seemed that the estimate of 0·05 per cent. per degree was not too much. For six degree curve, this would be 0·30 per cent.

Or, per ton, 0·0030 × 2,000 =	6·00 lb.
This gives a total resistance to be overcome of (per ton) =	36·40 lb.
Weight of engine and train being 747 tons; 747 × 36·4 =	27,191 lb.
But about 100 ft. of the train will be on a ten degree curve, where the resistance per degree is 0 05, or, for the ten degrees, 0 50 per cent.; the estimated resistance on a six degree curve was 0·30 per cent.; here is an excess of 0·20 per cent., or, per ton, 4 lb. Now, three cars are all of the train on this curve, and we have 69 tons, which gives 69 × 4 =	276 lb.
Making a total resistance to overcome of	27,467 lb.

You will note that here we develop a tractive force of 28 2 per cent. of the weight on drivers; not so great as in other cases, but much over ordinary practice.

The theoretical power of the engine would be as follows:

$$\frac{20\times20\times24}{50} \times \text{cylinder pressure} = 192 \times 130 \text{ (assumed)} = 24{,}960 \text{ lb.}$$

The estimated resistance per ton is:

Gravity	25·4 lb.
Frictional	5·0 "
Six degree curve	6·0 "
One-tenth of train will be on a ten degree curve; and we can add to this, one-tenth of the excess over six degrees, or one-tenth × 4	0·4 "
Total	36·8 lb.

Divide the theoretical power 24,960 by this resistance, 36·8, and we have:

24,960 ÷ 36·8 = 678 tons = 1,356,000 lb.

Being the theoretical amount the engine would move up this grade, or about 137,000 pounds less than the actual amount moved. As in the former cases, the actual work exceeds the theoretical by about the weight of the engine and tender.

Our estimate is based on an average pressure of 130 pounds in the cylinder, after a study of a "constructed" diagram of the probable pressure, assuming that when the valve was open we had 135 pounds, or within ten pounds of boiler pressure. We cut off at twenty-two inches (called full stroke) and a trifle later the exhaust opens. The loss here and the back pressure would reduce the average pressure at least five pounds, and probably more.

The next day a train was made up of twenty-four cars, freight, caboose, and coach, weighing 1,048,100 pounds. Engine and tender, as before, 164,000 pounds. Total, 1,212,100 pounds.

The day was a bad one, a fine, drizzling rain, so that the rail was as greasy as possible to be; the rail could hardly have been worse.

A run of one hundred and thirty-one miles was made over an undulating road, with 68 ft. grades and 6 and 8 degree curves, some long and some short, in 9 hours and 10 minutes, or an average of 14·4 miles per hour, taking no account of the stops in meeting trains. The object was to see the working of the engine on the road in its every day work and under the worse circumstances. Fortunately the rail was as bad as we could wish, and yet the engine took the lead easily and at a speed above the usual and desired speed of freight trains. Probably in no case did the pressure in cylinder exceed 100 pounds per inch, as a good speed was kept up. At these figures we would have developed a power of 192 × 100 = 19,200 pounds; dividing by resistance, say 35 pounds, and we have the result, as before, 548 tons = 1,096,000 pounds; or again, not far from the weight of the train without the engine. The trouble contended with this time was the liability of the wheels to slip. Our test satisfied us that our estimate of the every day capacity of the engines was correct, and that they would take 1,000,000 pounds besides their own weight over this part of road, with ease and at a good speed. They have since been doing it, taking one million to one million one hundred thousand pounds, at twelve to fourteen miles per hour, without the least trouble.

Knoxville, Tenn., Nov. 20, 1885.

Jour. Asso. Eng. Societies.

* On 6 degree curve to left.

BELT DYNAMOMETER.

THE chief requirements of a dynamometer are accuracy and sensitiveness, but neither of these qualities is fully realized in any known form of dynamometer, all of which are more or less unreliable and wanting in delicacy. Professor Hartig, who has made a very large number of dynamometrical experiments, quotes 12 per cent. as loss by friction for the instrument which he employed in his very extensive practice, and which he himself designed. This loss by friction cannot, however, remain constant under varying conditions, and a satisfactory correction of results is practically impossible, since the amount of friction depends on so many conditions, such as shape of teeth, smoothness of surfaces, lubrication, etc., that it may be safely asserted to vary in every experiment. The dynamometer designed by Hefner-Altenek has one great advantage over previous patterns, that of using transmission by belting, which admits of higher speeds and works noiselessly; yet as regards reliability the advance is not marked.

Another grave objection to existing dynamometers is

the use of levers and axles with large surfaces, causing undue friction, and moreover the internal resistances vary with the power transmitted.

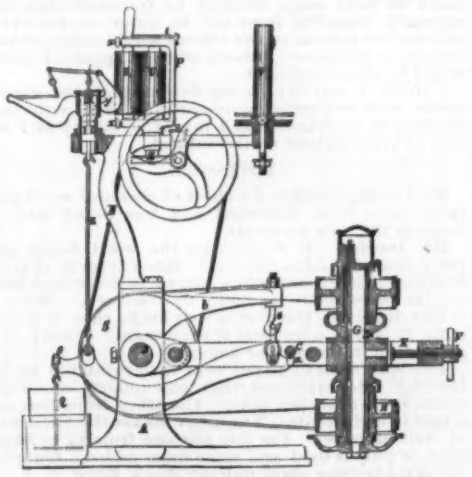
In a dynamometer designed by Mr. Donat Banki, and constructed in various sizes by Messrs. Ganz & Co., of Buda-Pesth, it has, says *Engineering*, been the object to eliminate, as much as possible, the faults of existing instruments. Of this dynamometer we give illustrations below, and will briefly describe it. A shaft, B, is fixed in the two standards, A, and carries the two loose double pulleys, S and S^1. Over these two pulleys a strap passes by means of the guide rollers, H H^1. A frame, C, pivoted at *c*, carries a crosshead, D, in which the shaft, G, upon which the guide rollers, H H^1, are mounted, is fixed. The crosshead, D, can be shifted lengthways in the frame, C, by means of the screw spindle, F, and nut, E, for the purpose of tightening the strap. The weight of the frame, C, and all its fittings rests upon the edge, *n*, which forms an extension of the lever, M, suspended from the arm, *b*, by means of hooks and edge, *m*. At the long tree end of the lever, M, a weight, Q, is suspended, which more than balances the weight resting on *n*, the surplus being carried by an indicator spring, *y*, through rod, *z*.

The registering apparatus is mounted upon the standard, N, and consists of an endless band of paper which forms the roller, V, passing between the rollers, U^1 and U^2, pressed against each other by the screw, *x*, and returning to the roller, V. A diagram is drawn by the indicator pencil upon the paper while passing over the roller, U^1. The roller, U^2, is driven by means of a worm and wormwheel, Z, from a countershaft driven from one of the pulleys, S, by means of a cord. The frame, P, carrying the paper rollers is mounted eccentrically, so that by turning it the wormwheel can be put in or out of gear with the worm. A revolution counter, driven by the same wormwheel, is provided at *t*. The wheel has 100 teeth.

The action of the dynamometer is as follows: We assume one of the pulleys, S, driven from the main shafting, while the other pulley, S^1, carries the strap which transmits the power to the machine the consumption of power of which is to be measured. It will be understood that as soon as motion commences, the tensions in the upper and lower parts of the dynamometer strap become different to what they were while at rest; the tension in the upper parts becomes greater, and is expressed by S_1 and $S_1{}^1$, while in the lower S_2 and $S^1{}_2$, it will be less. If there be no friction and no bending strain, then the tension in the near part of the belt would be the same as in the back part; in reality, it is greater in the latter. The moments of these strains act upon the lever, C, tending to turn it on its center, *c*.

The resulting moment is expressed by the formula $[(S_1 + S_1{}^1) - (S_2 + S_2{}^1)]$ R, where R represents the radius of the pulleys S and S^1, and S and S_2 the belt strains on the respective pulleys. In a somewhat complicated calculation, the inventor proves $S_1 + S^1{}_1 - (S_2 + S_2{}^1) = 2$ K, if K represents the circumferential strain on the pulley driving the machine under trial, and it is this result which forms the basis of the mode of measurement.

In consequence of the transmission of power through the dynamometer, part of the weight, Q, is released and shows itself on the indicator spring, *y*, with a force expressed by $\frac{2\,R\,m\,n}{c\,n \times m\,p} \times K = a\,K$; *a* being a constant coefficient depending only on the proportions of levers chosen. Any depressions upon the spring are registered by the pencil of the indicator upon the endless paper. There is a zero pointer, which should be set in such a position that the line drawn by it covers exactly the line drawn by the indicator when the dynamometer transmits no work. The frictional resistance of the two pulleys, S, S^1, does not enter into the calculations at all, while the resistance due to the guide pulleys is so exceedingly small that it may be neglected, since it does not exceed $\frac{1}{10}$ per cent. It is necessary that every time the dynamometer strap is regulated for tension, an empty diagram should be taken and the zero pointer set to it.



AUTOMATIC REGISTERING BELT DYNAMOMETER.

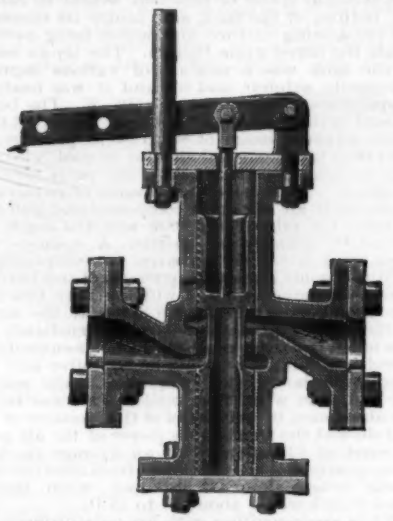
A large dynamometer with a strap nearly 11 in. wide has been constructed on the same principle by Messrs. Ganz & Co., and has been used with excellent results, it having proved equally accurate for the transmission of 1 to 100 horse power.

PROF. R. H. RICHARDS, of Springfield, Mass., has invented an ingenious and effective application of the zootrope, for the illustration of the relation between certain isomeric forms. The apparatus exhibits the gradual passing of a cube into an octahedron, a dodecahedron, etc. It can be used also for exhibiting the growth of hemihedral forms of crystals.

STEAM PRESSURE REGULATOR.

THE use of high pressures in steam generators is becoming more and more common by reason of the saving in fuel due to the elevation of the initial pressure. But in industries in which steam is used for cooking, for the evaporation of certain products, or for heat at a pressure, that is, at a temperature not so high as that of the direct steam designed for the production of motive power, it is necessary to use steam expanders. These devices, which may also be called pressure regulators, must operate automatically and permit of regulating the degree of expansion at will, from the lowest pressures up to those of the generator or steam pipe.

Such conditions appear to us to be realized in the apparatus which is represented herewith, and which is



STEAM PRESSURE REGULATOR.

being constructed by Madam Giguet. It consists of a cylindrical chamber of bronze in which slides a long piston of the same metal, which is provided with circular grooves that suffice to prevent leakages, as in the pistons of blowing machines. There is, then, no packing capable causing friction and injuring the sensitiveness of the apparatus.

From the arrows, it will be seen that the live steam enters an annular chamber, which is separated from another one like it by a partition to which corresponds a channel in the piston. It is through the diminution of this passage that we obtain an expansion of the steam in the upper chamber. To this effect, the latter connects with the interior of the piston through small apertures, formed beneath a solid ring, so that the pressure of the steam acts upwardly, in order to counterbalance the pressure exerted by a lever and counterpoise.

The position of equilibrium of the lever arm may be regulated for various pressures; but the degree of expansion, once established, preserves an absolute uniformity during the work. In this way steam is obtained of a determinate temperature for the service of various apparatus.

The regulator is extremely simple, and, unlike other similar devices, does not require the use of accessory safety apparatus.—*Revue Industrielle.*

NEW DEPARTURE IN MARINE ENGINEERING.

THE S.S. Bléville of Havre, recently built and engined by Messrs. Alex. Stephen & Sons, of Linthouse, Glasgow, for C. Brown, Esq., Havre, marks the beginning of a new stage in that economical consumption of coal toward which marine engineers have of late been diverting their best energies.

The Bléville is a steel screw steamer, 300 ft. by 40 ft. by 24½ ft., capable of carrying 3,800 tons dead weight, all told, and is fitted with triple-expansion engines of 210 N. H. P., having cylinders 21 in., 33 in., and 52 in. diameter and 42 in. stroke, with a working pressure of 160 lb. per square inch.

The principal novelty is in the design of the boilers. These are the Kemp's patent compound high and low temperature, consisting of two boilers of ordinary marine return tube type, 10 ft. 7 in. diameter and 10 ft. long, with two corrugated furnaces in each. In the uptakes of these boilers are fitted a series of stacks of tubes through which all the water circulates on its way to the high temperature boiler. The water enters at the top, so that the gases, when most spent, act on the coolest water, and thus the heat of the gases, which would otherwise be lost, is fully utilized.

During the trials on the Clyde, the feed water which leaves the engine, and in ordinary cases enters the boilers at about 120°, was raised to about 360° Fah. before entering the high temperature boiler. The temperature of the waste gases, on leaving the tubes of the ordinary boiler, was shown by the pyrometer to be about 630° Fah. This was reduced to about 300° in passing through the low temperature boiler, showing how much of the heat that generally is wasted is absorbed in this design.

In order to provide means of developing an extra amount of H.P. when desired, a fan is fitted inside the uptake at the base of the funnel, for increasing the draught. This fan is driven by a small auxiliary engine in the engine-room, and on trial was found to be very efficient.

A six hours' run was made with both boilers and natural draught, with the view of testing the coal consumption, as in ordinary conditions at sea. A speed of about 10½ knots was maintained with 60 revolutions of engine, and the coals burned were equal to 11·4 tons per 24 hours—no deduction being made for the steam used for steering gear.

One of the compound being shut off, the remaining one, with a moderate forced draught, drove the vessel at a speed of 10 knots; and even with natural draught maintained a speed of 8¼ knots. It is thus shown that with only one of the compound boilers, the vessel could be driven at her ordinary sea speed by resorting to the moderate use of the forced draught.

With both boilers working under moderate forced draught, 1,223 H. P. was indicated, and a speed of about 11½ knots obtained. Under these conditions it was found the boilers were capable of raising more steam than the engines could use.

The space occupied by the engines and boilers of the Bléville is 2 ft. less than that occupied by the compound engines and ordinary boilers of a sister ship, the Graville, recently build by the same firm, carrying rather less dead weight, and burning 17 tons coal per 24 hours on the same speed.—*Marine Engineer.*

MANUFACTURE OF PAPER BARRELS.

WOOD PULP, AND SOME OF ITS PECULIARITIES.

By MARK L. DEERING, Member of the Civil Engineers' Club of Cleveland.

IT is far beyond my ability at this time to go deeply into the subject of wood pulp. A description of it is a matter of much difficulty. To thoroughly understand the material, manner of treatment, and chemical agents used in its manufacture to insure uniformity of texture, requires many experiments and unlimited time. What I will say to you, therefore, will be somewhat more in the nature of personal experience and research than in a critical survey of the works of others. I will take only a hasty glance at the history and nature of wood pulp, and will try and devote the short time allotted this paper to the discussion of the difficulties to be overcome in its successful manipulation in what is known as the Deering seamless barrel.

Pulp originally meant the soft parts of bone and animal structure, especially the marrow; then the softer portions of certain fruits, until the digested straw and rags used in making paper was called pulp. As wood was used first as an adulterant in paper making, it naturally took the name of pulp—not an inappropriate one.

Twenty years ago I first became interested in this subject, probably from my curiosity at the novel manner of its preparation in a wall paper factory in New York city. This was known as "chemical pulp," and was treated with caustic soda and steam, and then digested. Very fine wall paper was made of this, and a firm in New York, and others who started at that time as pioneers in the manufacture of wood pulp, have since made immense fortunes.

The woods generally used are poplar, white and yellow pine, spruce, and cottonwood, pulp made from the last named being by far the best, and also much the highest in price.

The general mode of manufacture is to saw the logs up into billets of about one foot long, the bark being then carefully peeled off. After this the billets are boiled in order to extract the sap, and ground by means of special machinery. After being ground it is digested in a vat with linen stock, jute, or other material, in order that it may possess the necessary tenacity of fiber. To give consistency and weight, clay is added, which also fills up the interstices, and makes the mass present a better appearance. Sizing is very necessary. Resin, glue, starch, and sometimes Irish moss are mixed carefully throughout, until the requisite adhesiveness is obtained.

The principal uses to which it is put are in newspaper stock, all fine printing papers, wall paper (almost exclusively), water pails, tubs, wash basins, ink bottles, boats, observatory domes, and gunpowder.

After six or seven years spent in designing special machinery for barrel making in the largest cooperage in the world, I found that the principal trouble with which we had to contend was the leakage of liquids through the joints, between staves or elsewhere, during shipment. After thinking of this defect for some time, I decided, in 1879, to make a seamless barrel of wood pulp. After six years of constant research and experiment, I have come to the conclusion that this substance is one of the most discouraging to manipulate which has ever been taken in hand by the engineer. The mere mechanical handling of the material has caused many thousands of dollars to be wasted in experiment, and the proper curing or vulcanizing as much more, and satisfactory results are yet to be obtained.

Some of the more prominent examples might be mentioned casually. A certain company in Akron, O., have been trying for two years to make barrels of this treacherous material, and the last I heard they had yet to make their first one. A company in Hartford, Conn., have made thousands of good barrels, so far as appearance was concerned, but their trouble was in the final preparation to withstand the various vicissitudes incident to the life of a barrel. The difficulty of

proper vulcanization was the rock on which they split. An example in this city was a type case factory, which demanded a large outlay of capital (something over $50,000), being used in a protracted series of experiments. Notwithstanding the fact that they actually made some good work, they were obliged to go out of business, sell their special machinery and stock for a mere trifle, and give up the conundrum. They couldn't make their ware with any degree of certainty. A company in Brooklyn, N. Y., spent over $100,000 trying to make insulating material in the form of pipes to carry underground cables for telegraph and telephone companies. This was also a dead failure. Many other examples could be given of loss of time and money trying to solve the problem.

In none of the articles enumerated above do the difficulties approach in magnitude those experienced in the endeavor to make a seamless barrel, and I have caused to be placed before you a miniature oil barrel, together with the machine which made it. To show that there has been at least one good barrel made by my process, I will say that this particular one has been filled with refined petroleum for more than five years past.

You will notice that this barrel is in one piece, all the machinery necessary to form the inside having been withdrawn through the bunghole after the barrel was completed.

The first difficulty I had to contend with was in overcoming the shrinkage. This was exceedingly variable. Sometimes, before the barrel was fairly done, the chimes and head would draw apart, very similar to the action of cast iron under some conditions. It took six months to discover the cause and prescribe a cure, or rather a preventive, learning all about it at last by pure accident. When that was overcome, the trouble was to keep the shrinkage constant throughout the process of drying by means of artificial heat, which was accomplished after many further experiments.

The method of drying was as follows: I built a small oven of wood, like a dry kiln, and generated my heat with a Bunsen burner. This oven held twelve miniature barrels, and I raised the temperature very slowly through the Fahrenheit scale from 100 to about 250 degrees. This treatment was all right so far as the small barrels were concerned; they came out sound and true, and as hard and solid as a rock. It occurred to me about this time, however, to pour some liquid into the barrels. I tried water first, and was very much surprised to learn that it would soak through in every direction about as fast as I could pour it in. Refined petroleum was even worse. After some experimenting, I found that by soaking the barrels in a kind of varnish, made principally of resin dissolved in naphtha, then treating the inside with a bath of oil-excluding compound, which formed a sort of enamel on the interior, I had a barrel oil and water proof. Now, I was sure that if I could get this small barrel all right, certainly one of full size could be made on the same plan. Somewhere around here is where I made a mistake, which led to thousands of experiments (and the outlay of much more money than is creditable for me to mention) in my endeavors to obtain results satisfactory and constant.

Some of the engineers present have seen my large machine at work turning out full size oil barrels, *i. e.*, of 52 gallons capacity, taking the saturated pulp, and making it into a perfect barrel without seam or joint, turning out one barrel every ten or fifteen minutes. For the benefit of those who have not seen the barrels in process, I will show by these drawings—reference being had also to one of the barrels—how I managed to get the hole inside of it without adopting the well-known Chinese method of employing a small boy to hold up the head of each one from the inside, and then selling boy and barrel together.

In the first place, notice that the mould which forms the barrel has a compound duplex revolving motion, both speeds alike (about forty revolutions per minute), the frame which carries the mould having a direct revolution about an axis lying in a horizontal plane, and the mould proper having its bearings at right angles to the axis of the frame; taking its motion from a stationary internal gear through the medium of two bevel gears, one upon the mould and the other stationary upon a trunnion, which was, in fact, one of the bearings for the frame. The revolving of the frame caused the mould to turn in an opposite direction, while the mould was at the same time revolving in a vertical plane. In short, the barrel was turning around, and at the same time it maintained a circular movement, end over end.

Prior to filling the machine with pulp, a receiver (which was simply a cylinder of steel about 4 ft. diameter by 8 ft. high) was charged with air and water, by means of an air-pump, to a pressure of about 300 lb. to the square inch. The pulp was of the consistency necessary to cause it to flow freely through a six-inch pipe, standing vertically between the mould and the tank on the floor above. The mould being filled with pulp, the former, or device for deciding the thickness, and conveying air and water to the center of the forming barrel, and to discharge the surplus pulp from the center of the mass outwardly, was now inserted and expanded, making the bunghole. The bunghole being made, the machine was set in motion, and when on the first half turn, water from the receiver before mentioned was admitted into the center of the now forming barrel, when a pressure of about 250 lb. to the square inch was obtained. It was held at that pressure for about one minute and thirty seconds. This supplied the forming barrel with water, taking the place of that disposed of by centrifugal force, and the water admitted in the barrel kept it soft, in order that the fibers might be properly disposed as the machine revolved. At this point I substituted air for water, and with all the pressure I could maintain in the receiver (from 250 to 275 lb.), the water forming a very effective cushion to take the force of the air and transmit the same equally to the layer of pulp behind. The machine revolved about two and a half minutes under the air pressure, when it was stopped and inverted from the position it held when charged. While in this position another connection was made automatically through the bunghole with the tank upon the floor above, the water and pulp that remained loose in the barrel descending to the bottom, and being forced out through the opening and into the tank from which it was originally taken, by means of the pressure of the air within. The machine was again set in motion, water again admitted through the same orifice as before; the machine stopped and inverted as before. This operation was again repeated, when the air pressure was withdrawn, the machine stopped in the same position as held originally, the former, or part that made the bunghole, collapsed and removed, the mould opened, and the fully formed barrel was taken out.

As soon as convenient, the barrels were put into a dry kiln, which was heated by a wood fire to a temperature of about 250 degrees Fahrenheit, and remained there about thirty-six hours, being turned end for end two or three times during this period. They were then taken out and carried to the vulcanizing department, which contained a steam jacketed wrought iron tank filled with liquid. The barrel was inclosed in a cast iron skeleton frame of sufficient weight to carry it to the bottom of the tank, and insure its immersion in the vulcanizing mixture, mechanism being provided to rotate the barrel while therein. The liquor contained in the tank was a mixture of various ingredients, principally sulphur and oil, and it was heated to a temperature of about 400° to 550° F. The barrel remained in the vulcanizer about two hours, all the time under action of steam of 80 to 100 lb. pressure. They were then taken out and allowed to cool, when a cast iron bushing was inserted in the pulp forming the bunghole. Next came the process of enameling the inside with an oil proof compound and painting the outside; the bilge being blue and the heads white—similar to ordinary oil barrels. A common wooden bung being driven in, the barrel was completed.

To give some idea of the strength of this barrel when it was ten minutes old, I will say that two medium sized men besides myself have stood at the same time on the top of one of these barrels immediately after it was taken from the machine. One peculiarity of the barrels was that they would be far softer and heavier twenty-four hours after completion, if not put in the dry kiln, than when first made. This was because of the absorption by the barrel of the moisture of the air, and showed the tremendous power of the air pressure. A barrel of 52 gallons, with an average thickness of three-quarters of an inch, when fresh from the machine would weigh about 75 lb., and when thoroughly dried would weigh about 30 to 35 lb.

While experimenting with my vulcanizing mixtures, I accidentally discovered that a superior insulating material was the result of a few minutes' exposure to the contents of the tank of a common sheet of pulp, the cost being merely nominal, while the quality was pronounced far superior to the best hard rubber or gutta percha. I also succeeded in making a very good quality of sole leather by a little different process. So good, in fact, that a prominent shoe manufacturer fairly persecuted me because I would not make it for him, or, at least, tell him how to do it.

Of course, there has been some curiosity as to the cause which led to the suspension of the manufacture of the Deering seamless barrel. While I am free to acknowledge that the subject is anything but a cheerful one, still I feel it is only due this distinguished Society of Engineers that some explanation be made, no matter how distasteful it may be to me. With this I will close the paper and leave it with this club and the engineers of the world to give a solution to the problem, and perhaps some day supply the missing link necessary to perfect success.

In the first place, my machine was practical, and made a perfect seamless barrel. Secondly, I learned the art of making the fibers of the pulp porous enough to allow the water to pass through the mass, and yet with enough adhesive power to withstand an air pressure of 300 lb. to the square inch, and, during the process of drying, I was able to keep the fibers from becoming disengaged from the main body or from each other, and at the same time maintain the barrel in perfect shape when deprived of moisture. These two things were accomplished only after making hundreds of experiments and spending thousands of dollars. The only thing which eluded me, and caused the lack of success in placing the barrels on a commercial basis, was the necessary process of giving uniform strength. It is a fact that some of them were not strong enough to withstand the hard usage incident to transportation, and especially transfers from rail to water, or *vice versa*; and while a portion of the barrels would come out permanently competent, others, without apparent cause, would break in shipment.

I think I may say in conclusion that the experiments were conducted systematically, and with such measure of intelligence and inventive ability as I was able to bring to bear on the subject.

DISCUSSION.

Mr. Deering exhibited a sheet of chemical wood pulp paper made from basswood, and was asked why he employs the term chemical.

Mr. Deering.—It is made by the wood being properly treated. After the sap is taken from it, it is cut into short pieces, put into a caustic cylinder and heated. It takes about six hours to dissolve it. When it is first dissolved, the fiber is very long: then it is shot out. It is like a number of explosions. Finally, it is ground up in the regular engine.

Two specimens of paper were then exhibited by Mr. Deering. He explained that one quality was worth about three cents per pound. the other from four and a half to eight cents. The latter makes the finest kind of writing paper. For this purpose from 85 to 90 per cent. of pulp is used and some linen added. Gunpowder is made from wood pulp at Black River, N. Y. It is so inflammable that, if you put a match to it, it will explode. I think it is worth four or five dollars per pound.

Mr. Deering exhibited a miniature oil barrel, and said this barrel was made five or six years ago. It has been full of oil ever since. The machine in which it was made is entirely of iron. There is a mould inside the shape of the outside of the barrel. The pulp and water go in together. This part is made of perforated brass, so that the water can be pressed through the pulp.

Mr. Barber.—What size are the holes in the brass?

Mr. Deering.—There are 24 to the inch. In the machine the pressure was in two directions from the center, and there were two kinds of revolutions. The center of the mould was the center of the machine. The centrifugal force threw the pulp out.

Mr. Latimer.—How thick could you make the barrel?

Mr. Deering.—I could not regulate the thickness. This little barrel is about a quarter of an inch thick. The first one I made cost me about fifteen hundred dollars. I worked on it for nine or ten months. In some kinds of pulp the shrinkage is enormous. These little barrels used to shrink an inch and a half. They were made from straw pulp. This wood will shrink three-quarters of an inch to the foot. I tried everything to stop shrinkage, but without success. One day I was out of pulp, so I fell back on some that I had in an old tub. I put on a pressure of about 200 pounds. When the process was completed, I opened the machine, and found that I had a little barrel there, and the rest was mush. I found from this that the pulp had to go to a certain stage of decomposition before I could overcome the shrinkage. When I was in a hurry, I put in an agent to hasten decomposition. One of the hardest things to know is how to have the shrinkage constant.

Mr. Baker (looking at finished barrel).—Is this lighter than the wooden barrel?

Mr. Deering.—No, sir.

Mr. Baker.—What is the thickness?

Mr. Deering.—About five-eighths.

Mr. Baker.—Does painting check leakage?

Mr. Deering.—No; it is only an ornament.

Mr. Barber.—Can the wood pulp barrels be manufactured as cheaply as the wooden ones?

Mr. Deering.—In this State the material is worth about 20 cents.

Mr. Barber.—Can you compete with wooden barrels?

Mr. Deering.—We can and will in time. This barrel would hold water for a hundred years. You cannot soak water into it. If water is left on top for some time, you can scratch it, and you will find it perfectly dry. The sizing that is put in is waterproof sizing. When I got this I was not looking for waterproof sizing, I was trying to make it hard. The sizing used in this little barrel is perfectly oil proof; it is milk and lime mixed with the pulp as a cement. When dried at about 250° of heat, it is perfectly oil and water proof.

Mr. Latimer.—When was that oil put in?

Mr. Deering.—About five or six years ago. In one of my experiments I was examining a barrel in which I had gasoline. I had a lighted lamp in my hand, and I lowered it to look into the barrel. I do not know what became of the lamp. The barrel went into a million pieces, and I had no mustache or whiskers for months afterward. If, when a barrel is being made, I start the machine and give it ten turns, and then examine it I find the pulp in layers. For ten turns there will be ten layers. The revolving lays the fiber.

Mr. Latimer.—What is the difference between the strength of that and the ordinary barrel?

Mr. Deering.—I found that I could not get a uniform strength in the mode of vulcanization. I had a stock farm raising cows to supply us with milk, but we were obliged to try some other material.

A Member.—If the barrels were used roughly, would they break?

Mr. Deering.—Yes, sir. We shipped some to New York. Some came back, but others burst on the road. This question of strength is a valuable one to whoever can solve it.

Mr. Barber.—Where did they break?

Mr. Deering.—Wherever they were struck with great force.

Mr. Hermann.—Have you tried the process used in producing parchment paper?

Mr. Deering.—Yes, sir; but in no process could I get the material to go over one-eighth of an inch.

A Member.—Could you not put something into that pulp to make it tenacious?

Mr. Deering.—I might, but I do not know of anything but what I have tried.

Mr. Perkins.—Do they not make type cases of pulp?

Mr. Deering.—No, sir. Pails are made of pulp, but a pail is a simple article. I think some one will solve the problem. Whoever can solve it will have a valuable invention. I went to five or six chemists, and made them a proposition which would pay them one thousand dollars if they could show me how to overcome this difficulty. One chemist worked on it for several months. I paid one chemist a dollar an hour, and he looked into various books and offered suggestions from them. I came to the conclusion that I could earn a dollar an hour myself. There are in this country, France, Germany, and England, 1,600 patents for paint and sizing. I got all of these.

Mr. Latimer.—Do you know that they are making cross ties?

Mr. Deering.—It is all nonsense talking about paper rails and paper car wheels. The paper is put in them, but they are not wholly formed from it.

Mr. Baker.—In making cross ties you would want tenacity.

Mr. Deering.—You can take sheets of paper and cement them together.

Mr. Latimer.—I should judge that the question is the question of pressure.

Mr. Barber.—The manufacture of carbons used in electric lighting is very similar. One method is to press the material through a hole, another is to force it into the hole under a pressure of about 400 pounds to the square inch.

Mr. Deering.—A sheet of pulp could be made into a material like that barrel in two or three minutes.

Mr. Barber.—There is a firm manufacturing boats from paper. They are little shells. The sheet paper is probably used.

Mr. Holloway.—We are much indebted to Mr. Deering, not only for the trouble he has taken, but for the courage he has shown in giving us the details of his experience. We all know something of the personal attention he has given this manufacture, the difficulties he has met, and the ingenious methods by which he has overcome some of them. We know that in spite of his indomitable perseverance he has sustained loss and what appears to be, for a time, failure in this plan, yet he has had the courage to come before us and detail all his adverse experience, and give us very valuable information. It would seem that the principal difficulty he has had has been in the want of cohesiveness in the material, and the problem which waits to be solved is to overcome this by introducing some cohesive mixture. This must be very cheap. There is hardly anything that may not be accomplished by time, money, and brains, but the trouble is to make a manufacture a commercial success. I should think

that if a substructure of woven wire were placed in the mould, it would give the necessary strength, and the pulp would make it impervious. I dare say one thousand things might be tried and fail. The rapid destruction of the forests in this country necessitates the discovery of new methods for saving wood. The Standard Oil Company bring their timber from the Gulf of Mexico. Soon all the valuable pine timbers will be used. Something must be done to replace this loss.

Mr. Latimer.—This question may command a good deal of engineering talent. All that we can gather will be of value in solving this problem.

Mr. Gobeille.—A point that has occurred to me is that all articles manufactured from paper, such as elevator buckets, observatory domes, paper car wheels, have something to start with, but Mr. Deering began with the thing itself. Even the Hartford barrel is made in three pieces. It was a pretty bold thing to begin to make a barrel in this manner.

Mr. Baker.—Does not this pulp require wood?

Mr. Latimer.—It is made of twigs and small pieces.

A Member.—Is not straw pulp available?

Mr. Deering.—The shrinkage is so great I could not do anything with it. With reference to Mr. Holloway's remark as to my courage in coming here to give the details of my failure, it is a question whether it is a failure or not. It has cost a great deal of money, but I think that if we live ten or fifteen years we shall see the barrel made. Mr. Holloway's idea about the wire is a good one. It has occurred to me, but I am afraid it would not be practical. If you put wire in, it will not shrink as the pulp does. This barrel is about three-quarters of an inch. They are thin when made; the material would shrink away from the wire.

Mr. Holloway.—The question of shrinkage had occurred to me. The shrinkage is caused by the water that is held in suspension by the outer skins of the pulp serving as valves. If the pulp could be made in thin sheets it would obviate the difficulty. Mr. Deering said in his paper that he gets out more water by the centrifugal force than by the pressure. The trouble is that the first pressure put on the mould shuts up the openings.

Mr. Barber.—Does not the water permeate the pulp?

Mr. Deering.—The barrel is full of water when the pressure is let on.

Mr. Latimer.—I thank Mr. Deering especially for having brought these products here. I am very glad that these are oil barrels instead of beer barrels. One woman said that to paper we were probably more indebted than to any other manufacture, and especially because it gave us the records of the past. The present age will show us new advantages from its use. It appears to me that the difficulty to be overcome in this matter is the question of pressure. We know that the upper layers of coal are soft, and those much deeper are hard and brittle. If sufficient pressure can be put on the pulp to express every particle of water, I think it can be made of strength adequate to resist any blows.

Mr. Holloway.—The value of pressure is great, but no amount of pressure can compress water. Water is incompressible. If Mr. Deering could drive the water out of the pulp, he would have a perfect barrel.

Mr. Deering.—I had some time ago an offer from a man to make some car wheel brakes. He wanted to make them of pulp. We had a hydraulic press, but we never made a shoe. We had not power enough in the hydraulic press to press the whole shoe.

Mr. Latimer.—I saw one not long ago when I was in New York.

Mr. Deering.—I presume he makes them, but the moisture is not all pressed out. He fills up the fiber afterward.

Mr. Gobeille.—At the last meeting of mechanical engineers in Chicago, I saw paper car wheels. They are made of sheets very thin. All the pressure required is to get these sheets very close together.—*Jour. Asso. Eng. Societies.*

MACHINE FOR MAKING WREATH FORMS.

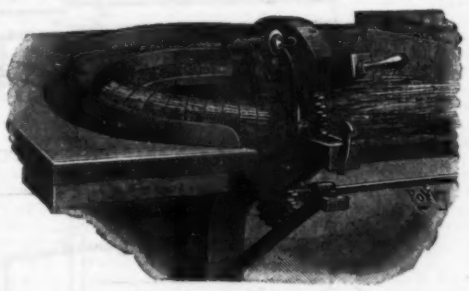
MR. GELLIT has recently presented to the Societe d'Encouragement a machine which he employs for making the straw forms that are used in the manufacture of wreaths of immortelles for funereal purposes. Mr. Gellit conceived the idea of this apparatus from seeing the women who gather immortelles preparing wreaths.

The flower that owes its name of "immortelle" to its imperishable nature after being dried in the sun is cultivated as an industry in the vicinity of the city of Ollioules, whose picturesque gorges are so well known to tourists. The culture is very lucrative. The flowers, which are cut in the mouth of June, are simply dried in the sun, put up in bouquets, and then packed in boxes that contain about 100 pounds.

About forty-two hundred pounds of flowers are produced per acre, representing quite a large sum of money, and the district of Toulon sells annually about $50,000 worth.

The flowers are dyed various colors, the dyeing being done by simply plunging them into certain baths (Campeachy wood, salts of iron, aniline, fuchsine, etc.), after first decolorizing them by a prolonged immersion in water. The forms, on which the flowers are simply sewed, were formerly made by winding around an inverted flower pot a bunch of straw bound with a string. In endeavoring to imitate this operation mechanically, it occurred to Mr. Gellit to employ a wire binder, which, in revolving and carrying along the bunch of straw, winds a wire around the latter and thus consolidates it. On another hand, a circular guide of proper diameter causes the straw to take a circular form, and soon carries its extremity to the binder, where it engages with the latter again and completes the form for the wreath. Then the excess of straw is removed, and the form, now perfect, would continue to revolve in the binder and take up more and more wire, were the binder not stopped and opened in order to remove the ring of straw. The binder has the general form of a toothed wheel, whose center contains a circular aperture of a diameter equal to the size of the form that it is desired to make. In consists of two separate parts, and stands in a vertical position. It revolves in a flat cylindrical box, whose lower half consists of a fixed piece carrying a pinion with which the toothing of the binder engages, and the upper half of a piece which moves on a hinge and which is raised when it is desired to remove the binder and separate the two parts in order to take out the straw form. One of the sides of the binder supports a bobbin of wire, which is thus carried along with it, and takes on a rotary motion around the bunch of straw. The wire wound on this bobbin passes into an aperture in the binder that runs through to the interior. It is only necessary to stop the extremity of the wire in order to make it wind automatically around the aperture.

The machine is fed by hand, and the form is made more or less thick and compact by properly regulating the size of the bunch of straw introduced into the binder. The operation is facilitated by a slight twisting motion that the bunch of straw receives. This motion is brought about by a spiral thread in the interior of the binder, and the pitch of which is proportionate to the latter's velocity. These threads likewise make the winding of the wire regular. The apparatus is set into an aperture made to receive it in the side of the table upon which the workman lays the bunch of straw that is to feed the binder. A belt passing under the table actuates the driving pinion, and causes



MACHINE FOR MAKING STRAW FORMS FOR WREATHS.

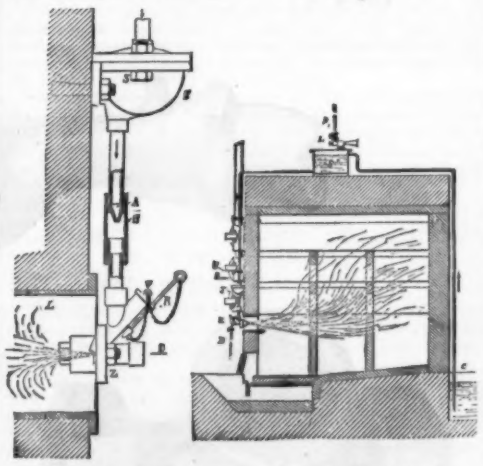
the binder to make about a hundred revolutions per minute.

A circular zinc guide, lying horizontally upon the table, directs the bundle on its exit from the binder, causes it to assume a circular shape, regulates its diameter, and finally leads it to the entrance of the binder again. It is possible, with a given binder, by simply changing the guide, to modify the diameter of the form, but without changing its thickness. Conversely, by preserving the same guide, but changing the binder, it is possible to make forms of the same external diameter, but of various thicknesses. In the ordinary course of manufacture, each binder corresponds to a guide bearing the same number, and gives the form a diameter appropriate to its thickness. Mr. Gellit manufactures fifteen numbers of forms, measuring from 12 inches to 1 yard in diameter. Each machine is capable of producing 75 forms of medium size per day, and the shop contains five machines, which are driven by a 4 horse power steam engine.—*Le Genie Civil.*

STEAM VAPORIZER FOR BURNING COAL TAR.

IT is certain that we shall before long succeed in increasing the industrial yield of petroleum, and in reducing the cost of carriage in a large measure, through shipments in vessels provided with tanks. This fuel will then be able to compete with coal for the heating of boat and locomotive boilers. The residua from distillation especially will offer serious advantages over coal in certain applications, owing to their great heating power, the ease with which they can be used, and the small space required to store them.

As well known, this question is analogous to the problem of utilizing coal tar for heating, and so vaporizing apparatus can, with a few slight modifications, be applied to either of these products. Now, in view of the extraordinary fall that has taken place in the price of tar, many gas works have decided to return to the use of this substance as a fuel for retort furnaces, after having discarded it for a few years.



STEAM VAPORIZER FOR COAL TAR.

But, in order to get rid of the inconveniences due to the abundant production of smoke that the burning of tar is accompanied with, it is necessary, before combustion, to project the liquid in the form of a spray, and to make as perfect a mixture as possible of its particles with the air. Under such circumstances, it burns normally with a white flame, and a great advantage may be derived from the heat that it develops.

In order to obtain such a result, the Messrs. Koerting Brothers have devised an arrangement which is distinguished for the simplicity and accuracy of its operation. The apparatus that serves for burning the tar is very strong, and is entirely of iron. As for the vaporizer, properly so called, that consists essentially of a pipe through which the tar descending from above is led to the front of the furnace, in order to be converted there into a fine spray through a jet of steam projected obliquely. The fuel reaches the furnace after being mixed with atmospheric air. With this apparatus, the vaporization of the tar is very complete, and, owing to the peculiar escape of the steam, there is no loss of fuel.

The annexed figure shows in section a four-retort furnace provided with a tar fire box, whose vaporizer is represented on a larger scale to the left. The tar is raised to the reservoir, S, by means of a pump or aspirator, L. The heat that prevails at the point where the reservoir is located keeps the tar continually in a liquid state.

From the pipe, E, the tar passes into the cap, T, which is provided with a semicircular sieve that can be easily removed for cleaning. This sieve holds back all the impurities that the tar contains. The tar afterward flows through the tuyere, A, the size of whose orifice varies according to requirements. In case this orifice gets obstructed, despite the action of the sieve, and after a somewhat extended period of service, it can be easily cleaned without taking the apparatus apart. To this effect, the socket, H, is raised, and this frees the tuyere, which can then be cleaned with a needle.

From the tuyere, D, the tar enters the vaporizer, Z, which is fixed, through a short sleeve, in an aperture in the front wall of the furnace. The jet of steam that enters the furnace through the conduit, D, makes a very fine spray of the tar coming from above, and, moreover, introduces into the furnace with great force the quantity of air required for the combustion. It results from this that the combustion proceeds under exceptional conditions. On each side of the vaporizer there are dampers for regulating the entrance of the external air at L, so that the draught may be neither excessive nor insufficient, and so that no smoke shall be produced. The combustion is further regulated by the steam valve. In case of a choking up of the vaporizer, which would be shown at once by a complete extinction of the flame or reduction of its intensity, the orifice of the apparatus is cleaned with the needle, R, after removal of the cover, V.—*Revue Industrielle.*

GAS LEAKAGE.*

THE subject of leakage is one about which we all have more or less interest—most of us more; a few less. Especially are we of the smaller towns frequently exercised over the discrepancy between the amount of gas made and that which our cash books show returns for; and although our plant is on the small scale, we generally possess a much greater showing of main pipes to annual output than is the case with our brethren in the big establishments. Indeed, as a rule, with those of the former class, the quantity of gas sent out per mile of main is very small. That and other items, such as smaller mains, and, consequently, of a class more liable to fracture, small service pipes, etc., cause the managers of small works to watch very closely over their leakage accounts.

Upon assuming charge of the Columbus (Ga.) gas works, two years ago, I immediately took a retrospective glance over the results of the operations of the company for the two or three years prior to my time of entering the company's service. I found the company's make of gas had been 9,000,000 cubic feet in the previous year; they had sold and used 6,543,000 cubic feet in the same time; and, consequently, had lost 2,457,000 cubic feet, or 27·3 per cent. of all the gas made.

An examination of the pressure gauges, etc., proved the fact, while the works could boast of a good pressure governor (when properly adjusted), that it was rather oddly handled. While the men in charge regularly put on and took off pressure at proper times, as they supposed, yet the operation was a mere form, because the valve of the governor was *not in position*, and the full pressure of the holders was on the street mains at all hours of the day, except for the partial control resulting from the eccentric regulation of a holder valve. This state of affairs was at once corrected, with the natural sequence of an immediate and important decrease in the leakage account.

I next by-passed the outlet valve with a one inch pipe, placed a 20-light meter on the by-pass, and on several Sunday mornings I shut down the valve, and compelled all gas going to the streets to pass through the meter. By watching this closely, and keeping a record of each hour, I soon found out just what amount of lost gas was due to leakage—we had a very small Sabbath day consumption, and I was specially convinced that our loss was due almost entirely to leakage, pure and simple, and was not traceable to slow meters, etc.

Where it was possible to do so, I by-passed each small line of pipe, and placed a meter thereon. At that hour of the day, when in reality no gas was being used, I kept close watch of the meter dial, in the attempt to determine the leakage on each particular line examined. I met with poor success, since, with only two exceptions, I found these lines to be in comparatively good condition. I then resolved upon examining the down town territory. A friend of mine (a gentleman connected with one of the large factories of our town, and who had watched with some interest my efforts to get at the seat of leakage trouble) informed me that every time he passed a certain corner of the main street, he "smelled something like rotten eggs;" and he thought "it *might be* that gas was leaking there." Next day, I had a force of men digging down after that "smell," and I found, at the particular point noted, nothing but a "smell." Its strength induced me to strip the main for a certain length each way. Having uncovered about fifty feet, I struck what was once a service pipe; but which had become the most "unserviceable" pipe imaginable. In fact, an attempt to remove any portion of it reduced the disturbed section to a fragmentary state, so badly was it eaten out. I took up each service on that particular block, and found all of them more or less eaten through from the tapping point in main pipe to the sidewalk. Under the sidewalk, however, the pipes were in good condition. As the services were seemingly bedded in soil which was of the same nature in both sidewalk and roadway, I was curious to find out why they (the services) should be in worse condition in one situation than in the other. The soil consisted of a sandy, clayey mixture, with not enough sand in its

* A paper by Mr. E. H. Jenkins, of Columbus, Ga., read at the Ninth Annual Meeting of the Western Gas Association, Columbus, Ohio.

composition to charge it with undue porosity, and I concluded that some other cause must exist for the rotten condition of the pipes than that afforded by the nature of their earthen covering.

I had taken up about a dozen services, when I approached one that had been only a comparatively short time in duty. This I expected to find in fair condition; but imagine my surprise when, on digging it out, I found it badly eaten with rust. The building which this pipe supplied is at the present time occupied as a dry goods store; but upon inquiry, I found that the premises had been formerly occupied by a retail dealer in groceries. I further found that these grocery men handled each year large quantities of salt meat. This salt meat (sometimes more like salt than meat) was hauled to the store and thrown on the sidewalk. During that process, of course, a good deal of the salt fell from the meat on to the sidewalk. Again, when the meat was sold it was brought out over the same route once more, and in the second handling new quantities of salt were deposited. The grocer's brooms in time swept the salt into the roadway, and the rainstorms washed the saline deposits into the subsoil, each additional dose sinking deeper underneath, and washing further along the roadbed, until finally the ground became thoroughly saturated with the evil. Here was where I found the greatest trouble—the salty soil had almost eaten the pipe completely up.

In relaying the services, I coated them heavily with coal tar, and hope by such means to make them last somewhat longer; but I have decided that pipes laid in such soil should be renewed at least once in ten years. In fact, I may find that they will need to be replaced in even a shorter period. I found several half inch service pipes that led to lamp posts, and in some instances small stores were fed from pipes of similar diameter. In nearly every instance I found these small pipes completely used up; and I submit that in no case should a service pipe of less than three-quarters of an inch in diameter be laid. Indeed, I would prefer to use even larger than this—the larger pipes, being thicker, stand longer.

Of course, I found a number of defective main joints, but the chief source of the leakage was traced to the defective services. We have taken out over 200 so far, and I expect to renew the balance soon.

The net result has thus far been a reduction in leakage, from 2,457,000 cubic feet in 1883 to 1,390,000 cubic feet in 1885, or a saving of 1,067,000 cubic feet per annum—a saving of 11·74 per cent., the reduction being from 27·30 to 15·56 per cent. In conclusion, the author recommended monthly reports on leakage.

GOLD'S SYSTEM OF HEATING CARS.

THE accompanying illustrations represent the apparatus used on the Manhattan Elevated and other railroads for heating cars. The danger of heating cars by stoves has often been brought prominently into notice by frightful disasters. In the Rio disaster, on the Chicago, Milwaukee & St. Paul, it would appear that the loss of life may have been solely due to the train catching fire through an overturned stove.

As the train was evidently running at very high speed, and was derailed almost as soon as the brakes could be applied, it thus appears that an ordinary stove when upset is more dangerous to life than an express train derailed at full speed. This is a grave reflection upon the common method of car heating, and shows that radical change is much wanted. The train would not have left the rails at Rio had proper switches or proper signals been in use; but even with the imperfect appliances used there, loss of life would probably have been prevented by a safe system of car heating.

The Gold system is based on the utilization of the heat in steam conveyed from the engine, and therefore requires no fire in any car.

It is important in any system of heating to have a constant supply of heat, so as to maintain an equable temperature. In heating cars directly with live steam from the locomotive, this is somewhat difficult to accomplish, as the live steam can with difficulty be spared during the ascent of grades, and consequently the steam is generally admitted to the heating pipes only during the descent of grades, and the supply of heat is therefore intermittent.

This difficulty can only be overcome by storing heat in the car, and the most obvious and convenient method is by placing a reservoir of hot water in the car. Water, weight for weight, will contain a larger number of heat units than any other substance, and holds the same superiority over most known materials when compared volume for volume.

In the Gold system of heating cars, the reservoirs which contain the water for storing the heat are constructed as shown in Figs. 3 and 4. A wrought iron cylinder, A, is filled with a strong solution of common salt to about seven-eighths its capacity. This leaves plenty of room for its expansion when heated, so that no undue strain is caused upon the apparatus by heating. This reservoir is hermetically sealed, and the solution is thereby maintained at a constant strength, proof against freezing and never needing to be replaced.

The reservoir is supported in a wrought iron cylinder of somewhat larger diameter, upon small supports at the bottom, which leave an annular space wider at the bottom and gradually narrowing at the top in cross section, as shown at C, in Fig. 4.

This inclosing cylinder is provided with caps, D, so adjusted as to leave plenty of room for longitudinal expansion of the reservoir, A, in the interior of the inclosing pipe.

In the caps at the lower part of the same are openings, E, into which the steam pipes are screwed, so that steam may pass in either direction into the apparatus, and pass freely out at the opposite end, together with the water which has condensed during its passage. The steam being thus applied to the outside of the water-containing reservoir, A, instead of being applied centrally through a small pipe as heretofore, gives a very much larger steam heating surface. In the short space of time during which a locomotive stops at a station, there is sufficient steam heating surface to adequately heat the solution in the reservoir, A, when steam is supplied to the space between the reservoir and its inclosing cylinder. As no strain can arise from expansion, no leaks can be so caused, and no expansion joints are needed.

FIG. 1.

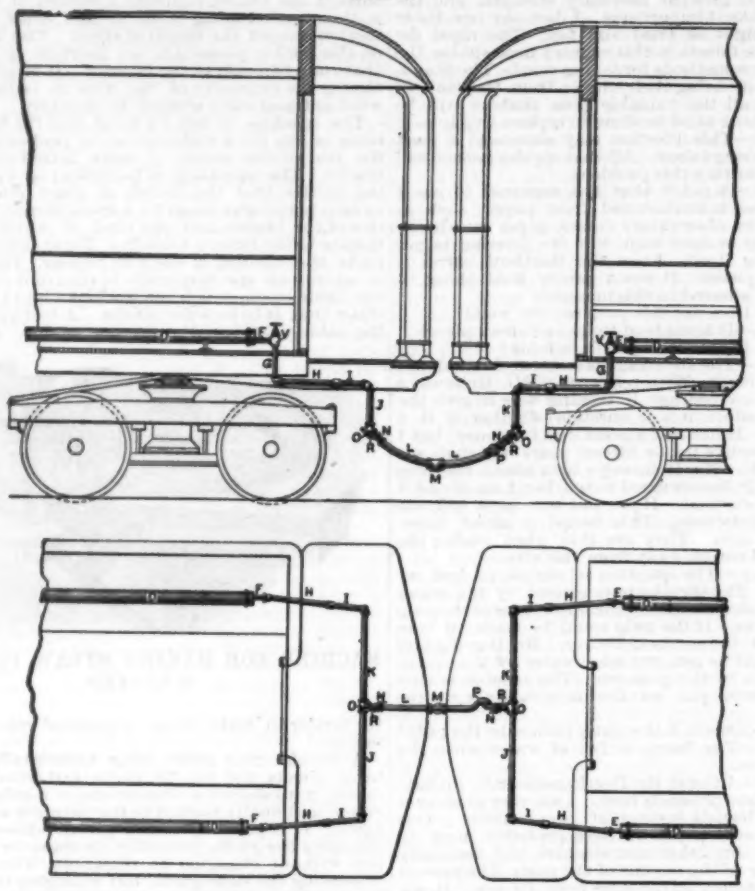


FIG. 2.—GENERAL VIEW.

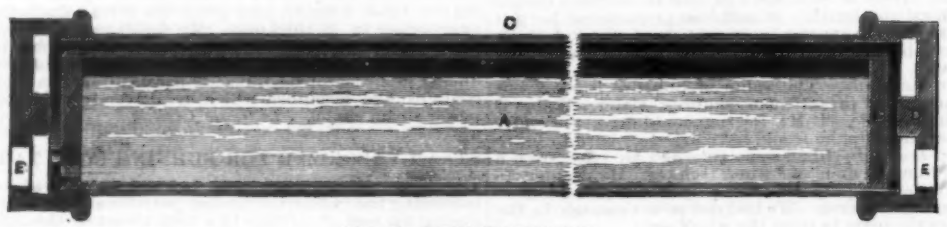


FIG. 3.—THE RADIATOR.

FIG. 4.

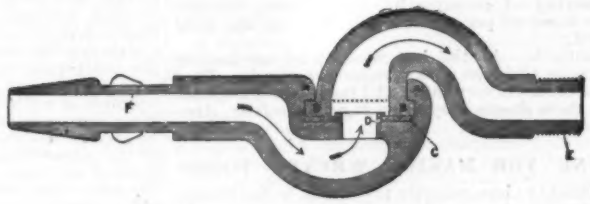


FIG. 5.

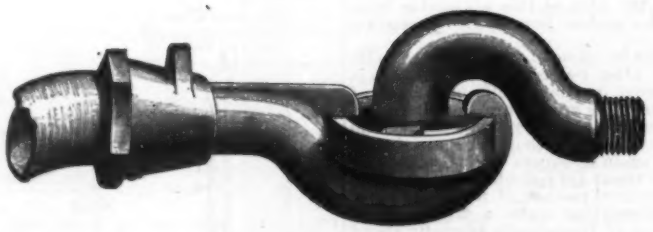


FIG. 6.—THE COUPLING.

FIG. 7.

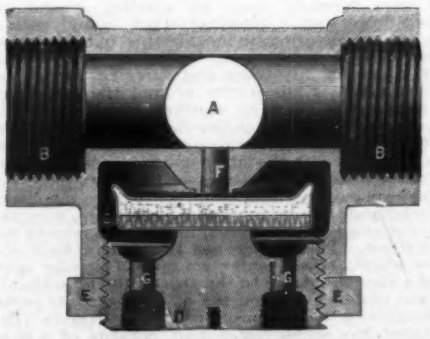


FIG. 8.

STEAM TRAP.

GOLD'S SYSTEM OF HEATING CARS.

A usual size of these heaters has been, for ordinary passenger cars, inner reservoir 3½ in. in diameter, the outer cylinder being 4 in. in diameter and 10 ft. 10 in. in length, the length varying according to circumstances.

The application of steam in the manner described enables the outer cylinder or pipe to instantly and powerfully radiate heat to the apartment to be warmed, while at the same time the reservoir, A, is absorbing heat for future use.

Figs. 1 and 2 represent the system as applied to suburban or rapid transit cars with longitudinal seats. In main line cars with the ordinary transverse seats, the heaters or radiators, D, would be placed close against the truss plank. In other respects the arrangement would be very similar. The steam passes from car to car through the pipes, F, H, I, K, and the hose pipe, L L, which is coupled to the next car at P. The coupling is shown in detail in Figs. 5 and 6. Stop valves are provided at V at the end of the radiators, so that steam can be shut off from one side of the car in moderately cold weather. Stop valves are also provided at N, so as to shut off steam from the whole car. Traps for the condensed water are provided at the lowest point of the pipes at each end of the car, and a trap, M, is also provided at the lowest point in the hose. The trap for the escape of condensed water is shown in detail in Figs. 7 and 8. The hose and the entire system of pipes are thus kept entirely drained of water, and consequently no trouble can arise from the pipes being obstructed or burst by ice. The pipes underneath the car should be felted to prevent useless radiation of heat.

The following is a detail reference to the parts shown in Figs. 1 and 2:

D. Car heater or radiator, 4 in. diameter.
E. 1 in. nipple.
F. 1 in. nipple.
G. 1 in. nipple through bottom of car.
H. Piece of 1 in. pipe.
I. Piece of 1 in. pipe.
J. Piece of 1 in. pipe, bent.
K. Piece of 1 in. pipe, bent.
L. 1 in. hose, five-ply.
M. Union trap at lowest point of hose.
N. 1 in. steam stop cocks.
O. Gold's 1 in. tee trap, iron body, at lowest point of pipe.
P. Gold's patent hose coupling.
R. Short 1 in. nipples.

The arrangement of pipes, flexible hose, water traps for removing condensed water, and couplings is the same at each end of the car. Steam consequently can be admitted at either end, as it will be discharged at the other end.

The coupling employed is shown in plan in elevation in Fig. 6 and in section in Fig. 5. It is very simply coupled, and tends to tighten by the motion and jarring of the train. As the ends, however, are male and female, it is best suited for lines where individual cars are not liable to be reversed. Any difficulty on this score might, however, be easily overcome by the use of two lines of hose.

Figs. 7 and 8 are respectively elevation and section of the trap used to get rid of the condensed water. It is very small, occupying little more space than an ordinary check valve, but it is claimed that it acts perfectly, allowing all condensed water to escape, and closing instantly when live steam reaches it.

The main principle of the trap is the use of a hollow expansion disk having thereon a valve face, which closes upon its seat by expansion whenever it is subjected to the temperature of live steam, and which contracts as soon as the temperature falls below the temperature of live steam, and opens the valve. This hollow disk is filled with a composition which is highly expansible at the temperature of live steam, and is so sensitive that it contracts very rapidly at points below that temperature.

This heater has been used on the Manhattan Railway for four winters, and is in use also on the Staten Island Rapid Transit Railroad, being applied in all on about 80 cars. It is also used on the Hoboken cable road, and on the Suburban Rapid Transit in New York, and in Wyandotte, near Kansas City.

As first used on the Elevated, the pipes were placed too low, and the guard rails, etc., projected too high to allow of a water trap being placed in the lowest point of the hose. Consequently, when the cars were left standing all night, the water accumulated in the lowest point in the hose, and, freezing, prevented any circulation of steam when the engine was coupled to the train in the morning. The result was that passengers complained that some of the cars were cold, while others in the same train were well heated. This trouble has not occurred since the trap was introduced in the lowest point of the hose as well as in the lowest point of the pipes at each end of the car.

The whole apparatus is tested to 350 lb. per square inch, and therefore is amply capable of standing the full working pressure of steam. The pressure is regulated by a valve on the locomotive operated by the engineer.

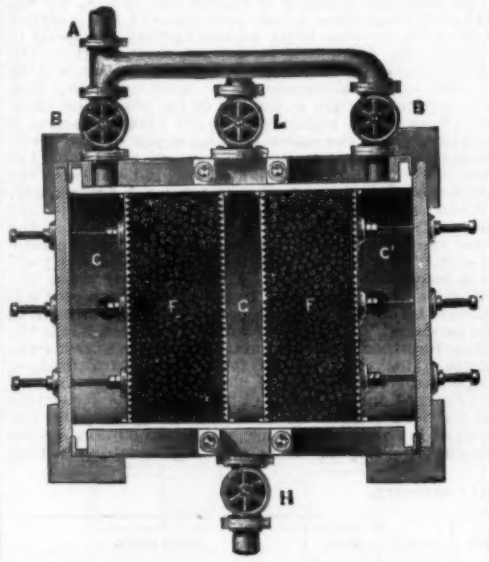
It is claimed that about 30 lb. of steam per hour will heat a car. As this quantity of steam should be raised by the consumption of 4 lb. of coal, it would appear that a train of eight cars could be heated by about 32 lb. of coal per hour. The steam used for heating would, however, probably be wasted at the safety valves were no heating apparatus in use. The consumption of coal, therefore, expressly for heating need not be large. It is claimed that the cars can run for two hours without receiving any steam from the engine, the salt water in the radiator giving out sufficient heat to keep the cars warm. There are few grades that cannot be surmounted by a passenger train in less than two hours, and while running down grade most engines can well afford to spare some surplus steam.

The Gold system of car heating appears to possess the merits of simplicity and safety, and deserves more attention from the managers of our great lines than it has hitherto received. Its first cost is, we understand, greater than that of stoves, but it would certainly appear to possess several merits to offset its greater cost. From the foregoing description, it is pretty evident that it would require less attendance than stoves, would heat a car more equably, and take up less useful space in the car. All these are points which deserve careful consideration, especially when they are combined with safety. Experience in actual running on main line trains would show whether the cost of maintaining hose and valves was an item large enough to outbalance some diminished cost of running in the items specified above. The question of safety should, however, be paramount; and it would be worth while to incur a possibly greater cost in running, especially when there is a strong probability that the safer system is the cheapest in running, though the dearer in first cost.—*Railroad Gazette.*

HIGH PRESSURE FILTER.

THE filtration of muddy river water, prior to its use in steam boilers and in manufacturing processes, is an operation which is coming more and more into vogue as the pollution of rivers and streams increases, owing to the increased density of population and the growth of manufactories. The purification which is sought to be effected by this form of filtration is mechanical, and refers only to the removal of solid particles, and no special attempt being made to obtain a potable water. Consequently a much more rapid process can be adopted than when the effluent has to be of a good color and free from objectionable smell and taste. At the same time, as the entering water is often laden with mud of a most objectionable description, means must be provided for cleaning the filtering material at frequent intervals.

To meet the requirements of manufacturers who often have to employ hard well water, while much softer but muddy water flows past their works, Bell's filter is being introduced in Lancashire by Messrs. Walter Glover & Co., of Bridgewater Street Iron Works, Salford, Manchester. The water, under pressure, enters at each end of the filter through the valves, B, and passing through the filtering material, F, enters the central compartment, G, from which it flows through the valve, H. A considerable amount of the suspended matter is deposited in the chambers, C and



BELL'S HIGH PRESSURE FILTER.

C', and on the outer face of the filtering material. An outlet (shown in black in the engraving, which is a horizontal section) is provided to each of these chambers, and is closed by a weighted valve. By raising and closing this valve rapidly, the chamber can be washed out, its contents being thrown into a state of regurgitation which flushes the mud off the surfaces and into the waste pipe.

When the filtering material has become fouled, the direction of the current is reversed. The water flows into the central cavity through the filters into the end chambers, and thence through the waste pipes, with the object of washing out the filters.

One of these filters is in use at the bleach works of Mr. John Walton, Pendleton, acting on water drawn from the Irwell, which is proverbial for its pollution. The boilers are fed from the filter and the steam is used in bleaching, the result in both cases being perfectly satisfactory.—*Engineering.*

DIFFERENT SYSTEMS OF TRANSMITTING MOTIVE POWER.

By JULES LAURIOL.

THE chief agents for the transmission of motive power to a distance, as now in use, are: electricity, water under pressure, compressed air, and tele-dynamic cables.

In the outset we must remember that the cost price of a unit of work at a given place depends: 1, on the cost of power supplied by the mechanical motor; 2, on the useful effect or the yield of the system of transference; and 3, on the first cost and the maintenance of the installation.

The first of these items varies greatly, according to the origin of the motive power (steam, water, or gas), the size of the machinery, the number of working hours, the price of labor, etc. According to Prof. Grove of Hanover, the hourly cost per horse power if supplied by a steam engine varies from 0·450 to 0·120 franc; if by water, 0·020; and if by a gas engine, it is 0·450.

Electric transmission, though the most recent system, shows already such advantages as to warrant us in entertaining the boldest hopes.

An electric transmission of motive power comprises a dynamo machine known as the generator, which transforms the mechanical work to be transmitted into electricity; a cable conducting the current produced to a second dynamo called the recipient, which reconverts the electric energy it receives into mechanical energy. Hence the yield of the system is composed of three parts—the yield of the generator, the yield of the conducting wire, and the yield of the recipient; and is the product of these three parts. We must further distinguish in the total useful effect the electric yield expressed by the ratio of the counter electromotive force developed by the recipient to the electromotive force produced by the generator, and the mechanical yield which is the ratio of the useful work collected on the pulley of the recipient to the motive power expended on the pulley of the generator.

If we suppose an ideal transformation of the forces, that is a complete conversion of motor work into electric energy, and reciprocally, the mechanical yield becomes equal to the electric yield, and we have:

$$E'_m = 1 - 0012\ L.$$

In this expression, E'_m denotes the useful effect, and L the length of the transmission. But such an ideal transformation can never take place. According to the most recent experiments, we may admit that 85 per cent. of the mechanical work supplied to the generator is converted into an electric current, while the recipient reconverts into mechanical work 75 per cent. of the electric energy which it receives. These losses are due to causes perfectly well known to electricians. We must therefore multiply the electric yield by the product of the two coefficients just indicated ($0{\cdot}85 \times 0{\cdot}75 = 0{\cdot}64$) to obtain the ultimate mechanical yield: $E_m = E'_m \times 0{\cdot}64 = (1 - 0{\cdot}0012\ L)\ 0{\cdot}64$. For a transfer of 100 meters, $E_m = 0{\cdot}649$; for 1,000 meters, 0·642; for 10,000, 0·570; and for 20,000, 0·500. This last distance will rarely be exceeded in practice.

For transmitting five horse power the expenses of the installation, including the two dynamos, the cost of fixing them, and the conducting line, will be for 100 meters 8,375 francs.

If we base our calculations upon the yield as given above, and allow 16 per cent. for interest on capital, paying off first cost, we obtain the figures given below for the hourly cost per horse power, supposing the motive power to be originally furnished either by a large steam engine of improved construction or by a hydraulic machine.

One hundred horse power, if supplied by a steam engine, may be transmitted 20,000 meters for 0·480 franc hourly per horse power, but for 0·120 franc if the original motive power is water.

TRANSMISSION BY WATER UNDER PRESSURE.

This kind of transmission has the advantage that the power consumed at each point of the distribution can be very exactly measured by the volume of water passed into the motor of the subscriber. No other method of transmission possesses this advantage in an equal degree. The conducting pipes for water under pressure are relatively costly, but compressed air presents in this respect no advantage, as there are the same expenses for taking up and relaying the public roads. The electric system presents in this respect an especial advantage, since an electric conductor for the transmission of an equal amount of power is much less bulky than a main of compressed air or of water under pressure.

The water system has, therefore, no marked advantages; if introduced into houses, it certainly allows of combating the first outbreak of a fire, but the leakage from the joints of the pipes is often annoying. If the quantity of power to be transmitted is at all important, mains of a large diameter are necessary, and the hydraulic motor cannot be removed, if this is desirable, without costly work. It is much less portable than the electric motor. There is also the risk that, in a severe winter, frost may burst the mains, or may at least stop the working of the system.

A transmission of this kind is composed of: 1. A forcing pump to raise the water, if this is not at a sufficient level to give the requisite pressure. 2. The main and the accumulator. 3. The hydraulic motor, which may be a turbine. The yield of power in the forcing pumps may be taken at the mean as 85 per cent. The useful effect in the pipes for pressure not exceeding 25 atmospheres ranges from 0·98 for 100 meters in length to 0·40 per cent. for 20,000 meters. The yield of the hydraulic motors employed most generally is from 0·60 to 0·70. From these three useful effects the total yield may be found as below, taking as before 16 per cent. for interest, etc., and assuming that the initial motive power is furnished either by a large steam engine or by a hydraulic motor. The hourly cost per horse power for the transmission of 100 horse power to the distance of 20,000 meters is 0·997 franc, if the power is obtained from a steam engine, and 0·369 if it is derived from a hydraulic machine.

TRANSMISSION BY COMPRESSED AIR.

Air compressors, established where the motive force is to be produced, compress the air, which a system of pipes then distributes among the various consumers.

Compressed air may be employed with advantage in tunnels, and wherever the yield of motive power plays a secondary part. But if power has to be distributed to numerous establishments, the useful effect is reduced to a maximum of 50 per cent.

Transmission of compressed air presents, therefore, as much inconvenience as water under pressure. Its application seems useful, at most, in perforating tunnels and the galleries of mines. Even there the electric system has the advantage of being more easy to establish. It is far easier to place, and especially to extend, an electric conductor than a pipe conveying compressed air, especially where it is required to traverse low, narrow galleries, and to convey the motive force to perforating machines.

On the other hand, perforators worked by air often suffice for ventilation, while the electric system presupposes special ventilating arrangement. Yet such is the advantage of electricity in economy and simplicity, that the electric system is preferable wherever there is no fear of the sparks from the dynamos igniting explosive gases. Electricity can serve at the same time for lighting, while compressed air necessitates the employment of separate lights, which help to vitiate the air of the tunnel or the gallery.

For the useful effect of the air compressors we take the coefficient 0·75 (a figure which has not been exceeded at the Gothard); as for the yield of the air motors, we may take 0·60 as the mean for good permanent plant. The loss in the mains is slight, E' ranging from 0·998 for 100 meters to 0·700 for 20,000 meters. Hence we find in round numbers $E_m = 0{\cdot}45$ for the former distance and 0·35 for the latter. The yields are much smaller for boring machines. The hourly cost,

therefore, per horse power, of conveying 100 horse power to the distance of 20,000 meters is 0·666 franc, if the initial motor is a steam engine; and 0·350 if it is water power.

TRANSMISSION BY TELE-DYNAMIC CABLES.

This system, invented in 1850 by Hirn, and analogous to transmission by driving bands, is the simplest of all. The cable rests upon two pulleys, so that the tension is due simply to the weight of the cable. If the distance is too long, additional pulleys are placed at every 100 meters by way of supports. Notwithstanding its simplicity, this system is being generally abandoned. The expense of maintaining the cables is considerable. They require to be renewed annually, and when new they stretch and require to be frequently shortened. Sometimes they break, which occasions much danger when they pass over streets, especially as they are generally moving at a high speed. They are best adapted for transmission of motive power in country places, but they cannot be employed for the subdivision of power.

The losses are those due to friction, to the resistance of the air, to the slipping of the cable on the pulleys, and to its rigidity. The yield for distances not exceeding one kilometer is 90 per cent. Beyond this limit it falls very rapidly as compared with the other systems, so that for five kilometers it has no advantage. The hourly cost per horse power of transmitting 100 horse power to a distance of 20 kilometers is 321 francs or 0·353, according as the initial power is supplied by a steam engine or by water.

TRANSMISSION BY COAL GAS.

The use of gas engines has been extended in consequence of the easy installation of these machines and the facility of setting them in action. They require no special superintendence, and the consumption of gas ceases as soon as the engine is at rest. The power supplied, however, is costly; there is also required a supply of cold water to effect the refrigeration of the cylinder, and there is much more danger than in any other system.

TRANSMISSION BY STEAM AND BY RAREFIED AIR.

The former of these systems has been tried at New York, but it has been abandoned in consequence of the serious difficulties occasioned by the condensation of the steam. The second system has been attempted at Paris, but its returns are not much higher than those of compressed air.

The figures already given under the first four systems admit of an easy comparison of their respective advantages.

If we assume that the local circumstances are equally favorable to any system, the comparison of the prices shows that electricity or tele-dynamic cables are the most advantageous agents for the transmission of power. Of these two we select the cables as the most economical for short distances (up to one kilometer), and for longer distances electricity. In cases where tele-dynamic cables are inapplicable, the electric transmission is far preferable to transmission by water under pressure or by compressed air.

The subjoined table summarizes the cost of the transmission of 100 horse power by the different systems which we have analyzed.

DISTANCE OF TRANSMISSION.

System employed.	100 m.	500	1,000	5,000	10,000	20,000	Initial motor.
Electricity	0·187	0·192	0·202	0·236	0·296	0·480	Steam engine.
Water under pressure	0·236	0·246	0·272	0·420	0·603	0·997	
Compressed air	0·330	0 336	0 347	0·442	0·547	0·666	
Tele-dynamic cable	0·131	0·155	0·165	0·300	0·520	1·321	
Electricity	0·048	0·050	0·055	0·065	0·071	0 120	Hydraulic machine.
Water under pressure	0·048	0·057	0·065	0·139	0 232	0·369	
Compressed air	0·075	0·083	0·087	0·126	0·194	0 350	
Tele-dynamic cable	0·026	0 028	0·031	0·083	0·148	0·353	

We see that the transmissions of power by electricity are much more economical than those of water under pressure or by compressed air; so that if we wish to produce power in a central establishment and distribute it from house to house in a radius of 10 to 20 kilometers, electricity alone can solve the problem economically. Thus, if we divide the region to be supplied with power into blocks of 10 to 15 kilometers square, having each a large steam engine, one horse power might be supplied at the hourly cost of 0 30 franc, while with a gas engine the hourly cost per horse power is 0·45 franc. With a hydraulic motor the cost per horse power is only 0·10 franc, which constitutes an important economy in favor of electricity.

In virtue of the important advantages which it possesses, the electric transmission of motive power is destined to receive a great number of applications; as soon as central establishments for the production of electricity are arranged for effecting the distribution to houses, electric motors cannot fail in many places to supersede steam engines, etc., within a wide circle, especially if we consider that electricity at the distance of 20 kilometers (in round numbers 12 miles) does not cost more than the same power produced on the spot by an improved steam engine of 100 to 200 horse power, not consuming more than 1,300 to 1,500 grammes of coal hourly per horse power. The advantage will be still greater at smaller distances and when it comes to supersede gas engines and small steam engines of 20 horse power or under, which consume as much as 2 to 3 kilos of fuel hourly per horse power.

Besides, dynamos have the advantage of simplicity over all the motors now in use. Their only movable part is a shaft turning in a pair of plummer blocks and carrying one or more bobbins of copper wire in perfect equilibrium. The mechanical resistance due to friction is reduced to a minimum, and there are no losses like those due to the condensation of steam, to the bad packing of pistons and valves, and to the shocks of the parts in motion. The materials constituting the machine, soft iron and copper, are not exposed to wear by reason of constant work, and, consequently, their depreciation is minimized.

The electric motor has further the following advantages over its rivals:

1. Easy removal, since in order to set it in motion it merely needs to be connected with the general circuit by means of two flexible conductors.
2. Small weight for a given quantity of work.
3. Possibility of acting well at a very great distance from the initial motor.
4. Excellent yield at high speeds; these motors are especially suitable for impelling apparatus which requires to act at great velocities without requiring intermediate transmissions, which uselessly absorb a quantity of the power.
5. Absolute neatness and security, since these motors produce neither smoke nor ashes, and yield no sort of refuse.

In consequence of the portability of these machines, they can often be brought up to the work to be done in place of removing the latter to the source of power.

In order to arrive at the general and ultimate employment of electricity, we must above all things seek to reduce as far as possible the cost of producing the electric current. The methods now in use for obtaining it are inconvenient and costly, since we require boilers, engines, and dynamos to transform the carbon of the coal (better, the energy liberated by the oxidation of such carbon) into electricity. Hence there is a notable loss, which requires a large quantity of work to render remunerative. But when a great central establishment shall furnish electricity so as to give light, motive power, and heat to houses, shops, public establishments and manufactories, we shall be present at a wonderful revolution. We shall reach this end only by establishing large works for generating electricity on the banks of rivers, so that the dynamos may be driven by hydraulic motors, which are much more economical (both in first cost and in maintenance) than the best steam engines. The rivers of France represent a power of 15 or 20 million horse power, which at present runs to waste.

To show the economy of electric appliances, we will take for comparison a hydraulic crane of the power of 3,000 kilos (3 metric tons), admitting that the speed of raising the load is ½ meter per second. Here the theoretic work of the crane per unit of time is 3,000 × 0 50 = 1,500 kilogrammeters; and supposing that the apparatus gives a yield of 60 per cent., the effective work at the piston will be 250 kilogrammeters if the pressure of the water is 50 kilos per square centimeter, the volume of liquid necessary to execute the above work will be 5 liters, and the diameter and the stroke of the plunger will be arranged accordingly. When such a crane lifts a load of three tons, it works normally and its yield is at a maximum. But if the load raised to the same height is only one ton, the same quantity of water will still be expended and the yield will be only 33 per cent. With an electric crane the effective work developed by the recipient motor will always be strictly proportionate to the useful work to be produced, i. e., to the load to be raised. It is the same for other machines, such as those for working the gates of locks and sluices, for working turn bridges, capstans, etc. The use of electricity as a mechanical power for domestic uses will be certainly as important as for electric lighting. Electric energy may be employed in the household for setting in motion sewing machines, pumping water, working elevators, turning washing machines, etc. The author goes on to show the advantages of electricity in workshops, where it may supersede driving bands—a constant source of danger.

Summing up, M. Lauriot says that the transmissions of motive power by electricity have every claim to be recommended and employed, first, because they are of wider scope than transmissions based upon the continuous displacement of any material substance (gas, steam, air, or water) from the place of its production to the place where the energy is to be employed, and then because of its undoubted superiority and convenience in use. The energy is transformed into heat only for such applications as require it, and it is superior even to gas in such cases as require the concentration of a great quantity of air at a given point and for the conversion of heat into light.

Where mechanical work is required, the energy passes directly from the electrical to the mechanical state by means of apparatus less costly, less bulky, and easier to manage than the simplest appliances necessary for effecting the same object.

As for distribution, properly so called, the natural superiority of electricity is at once manifest.—*Le Genie Civil; Electrical Review.*

AUSTRIUM, A NEW METALLIC ELEMENT.

LINNEMANN has announced the discovery of a new metallic element in the orthite from Arendal, to which he has given the name austrium. To obtain it the mineral is treated with hydrochloric acid, the solution treated with hydrogen sulphide to remove the lead, copper, tin, and arsenic, the filtrate nearly neutralized or mixed with sodium acetate, and hydrogen sulphide again passed through it. The precipitate now obtained contained copper, lead, zinc, cadmium, thallium, iron, calcium, magnesium, and austrium, these metals being detected by the spark spectra of their chloride solutions. This precipitate was dissolved in hot hydrochloric acid, the excess of acid evaporated, the solution treated with caustic soda in excess, filtered, the filtrate precipitated, after warming, with sodium sulphide, the precipitate filtered off, and the filtrate allowed to stand exposed to the air. The austrium which it contains is thus converted into carbonate and partly precipitated, mixed with sulphur. On acidifying the filtrate with acetic acid, evaporation to dryness, solution in water, and treatment with hydrogen sulphide, nearly all remaining in solution is thrown down mixed with traces of copper, lead, and zinc, separation from the latter being especially difficult. The spark spectrum of the metal austrium is characterized by two violet lines; one of these, Aus α, has a wave length of 4165, the other, Aus β, has a wave length of 4030. The former appears to coincide with the solar line 4164·7 of Angström.—*Monatsch. Chem.*, vii., 121; *Ber. Berl. Chem. Ges.*, xix., 431, July, 1886; *Amer. Jour.*

SOME PROCEDURES OF QUALITATIVE ANALYSIS BASED UPON MICRO-CHEMICAL REACTIONS.

BORICKY made the first attempt to dispense with filtrations and to use only one principal reagent, hydrofluosilicic acid, which serves to distinguish the bases contained in a silicate. He spreads upon a glass slip a thin layer of Canada balsam, moderately dry, fixes in it by fusion a small fragment of the mineral, and places upon it a drop of the acid. The action is allowed to go on in the cold for twenty-four hours in a moist place, and the preparation is then left for twenty-four hours longer, still in the cold, in dry air. The bases of the mineral pass into fluosilicates, which crystallize slowly and are examined with the microscope. Those of the magnesian series (magnesium, zinc, manganese, iron, nickel, cobalt, copper) all crystallize in hexagonal crystals, and are respectively distinguished by their color and their behavior with ammonium sulphide. The process is especially applicable to potassium, sodium, and calcium. Potassium fluosilicate, a sparingly soluble salt, forms regular cubes or octohedra of remarkable limpidity, absolutely monorefringent. The corresponding sodium salt, more soluble, forms hexagonal prisms, sometimes bipyramidal, with a uniaxial double refraction, very slight and negative. The calcium salt is very soluble, crystallizing in lamellæ, spindles, or oblique prisms with curvilinear outlines, strongly double refractory.

Th. Behrens has published a method for detecting a large number of elements in a fragment of a mineral less than ½ mgm. The portion, finely powdered, is attacked in a platinum crucible with a few drops of pure hydrofluoric acid or by ammonium hydrofluoride mixed with hydrochloric acid. He evaporates, redissolves in sulphuric acid to decompose the fluorides formed, evaporates again, and finally redissolves in water acidulated with sulphuric acid. This drop containing the sulphates is fractionated by means of a capillary pipette, and serves for the various assays.

Calcium is recognized by the prisms and needles characteristic of gypsum, being deposited as the drop evaporates.

Potassium.—To the drop is added platinic chloride, which gives the usual precipitate in small regular yellow octohedra.

Sodium (and Potassium).—The author uses a reagent, cerous sulphate, which gives crystalline precipitates with sodium and potassium; the former gives granules much finer and less soluble.

Lithium.—After removal of calcium in the state of gypsum, the liquid mixed with sodium carbonate gives prisms of lithium carbonate with rectangular apices.

Barium and Strontium are found in the state of insoluble salts at the bottom of the platinum capsule along with excess of gypsum. They are soluble in boiling sulphuric acid. This solution on dilution and cooling deposits first barium sulphate in very small lenticular crystals, laid crosswise, then strontium sulphate, in crystals similar but much larger, and lastly gypsum.

Magnesium is detected as magnesium-ammonium phosphate.

Aluminum is recognized by the addition of a solution of cæsium chloride, which yields regular octohedra of cæsium-alum, very slightly soluble.

Sulphur.—The substance is converted, if needful, into a soluble sulphate, and chlorides of aluminum and cæsium are added to form cæsium-alum.

Phosphorus and arsenic are converted, if needful, into soluble phosphate or arseniate, and the ammonium-magnesium phosphate or arseniate is produced. Arsenic is distinguished by heating the substance in a small tube with sodium carbonate and potassium nitrate.

Chlorine may be recognized by the addition of acid lead nitrate. If there is sulphuric acid in the liquid, thallium sulphate is used instead, which precipitates thallium chloride in very small regular octohedra or rhomboidal dodecahedra, often in groups and presenting a remarkable refraction. Instead of searching for chlorine in the solution of the mineral, it is preferable to distill the latter with sulphuric acid, placing a drop of cold water in contact with the vapors given off, which are thus condensed, and serve for the assays. Bromine acts like chlorine. We may also recognize chlorine by a mixture of platinum and potassium acetates, which give rise to the formation of the double chloride.

Fluorine.—The mineral (previously opened up, if necessary, with sodium carbonate and moistened with acetic acid) is heated with sulphuric acid, adding, if needful, silica or powdered glass. The vapors are condensed under a little platinum lid moistened with a drop of dilute sulphuric acid. If fluorine is present, it passes into the acid in the state of hydrofluosilicic acid. This is deposited upon a slip coated with Canada balsam, and sodium chloride is added. There are then formed rosettes, hexagonal tables, and bipyramidal prisms of sodium silicofluoride.

Boron and Silicon.—We proceed as for the detection of fluorine, but we distill with fluor-spar. The silicon and boron pass into the drops in the state of hydrofluosilicic and hydrofluoboric acids. We add to these drops, as above, sodium chloride, which yields a silicofluoride and a borofluoride, both crystallized in rosettes, tables, and hexagonal prisms. To decide between silicon and boron and to demonstrate the presence of both, if needful, we add potassium chloride, which yields the well-known silicofluoride (see Boricky's process, above) and a borofluoride in narrow plates with acute apices or rhombic crystals, much more soluble than the silicofluoride. If both boron and silicon are present, it is well to fraction-

ate the products of distillation, as boron fluoride is evolved only in the second place.

Water is found by heating the fragment in a glass tube with a drawn out point. The deposit is concentrated in the capillary part, and the reaction may be rendered more sensitive by the introduction of a tiny fragment of magenta, which, under the influence of moisture, loses its metallic luster, giving a red transparent liquid.

M. Streng indicates a method of effecting microchemical filtrations and washings of precipitates, operating upon a few drops of liquid. He uses a band of filter paper arranged on a glass slip slightly leaning; the drop to be filtered is placed at the upper end. He describes also the following micro-chemical reagents:

Chlorine (and silver).—Silver chloride is an amorphous precipitate, not characteristic under the microscope, but it becomes so if dissolved in ammonia and allowed to evaporate, when it is deposited in octohedra, cubes, or cubo-octohedra. It may further be heated in strong hydrochloric acid; on cooling, silver chloride is deposited in octohedra.

Selenium.—Sulphurous acid is allowed to act upon the drop, when the selenium is thrown down in small opaque grains.

Phosphorus is converted into a soluble phosphate; silica, if present, is eliminated, and the phosphorus is recognized as ammonium phospho-molybdate.

Antimony is converted into a hydrochloric solution, and there is added barium tartrate precipitate suspended in water. If antimony is present, the liquid on slow evaporation deposits rhombic crystals of antimony barium tartrate.

Sodium and Uranium.—On adding uranium acetate, sodiferous solutions deposit uranium-sodium acetate in regular tetrahedra of a pale yellow. The uranium acetate used must be very pure. Inversely, uranium may be recognized by the use of a solution of sodium acetate.

Lithium.—The author uses sodium phosphate, which yields a precipitate of lithium phosphate in spindles and stellar groups.

Calcium, Strontium, Barium.—Oxalic acid produces in calcium solutions octohedra or rhombic tables; the two metals are distinguished by the action of sulphuric acid upon the crystals. There is nothing similar with barium. Barium solutions yield rhombic crystals with tartar emetic; those of strontia act similarly, but the crystals formed are less soluble. Barium tartrate forms rounded granules, while strontium and calcium yield crystals. Potassium ferrocyanide, added hot to a barium salt, forms, on cooling, a deposit of barium and potassium ferrocyanide, in pale yellow rhombohedra.

M. H. Rosenbusch, in his "Microscopische Physiographie," mentions the following reactions:

Barium chromate, formed by precipitation, quite resembles the crystallites of barium sulphate deposited in hot sulphuric acid.

Glucinum solutions, mixed with platinum chloride, yield on slow evaporation crystals of glucinum chloroplatinate in square or octagonal tables, almost colorless and optically negative uniaxial.

Chrome is converted into alkaline chromate, and a solution of silver nitrate is added. Silver dichromate is formed in rhombic tables, often truncated at the obtuse angles, of a hyacinth red and strongly refringent.

Cerium.—Oxalic acid or ammonium oxalate gives a flocculent precipitate which crystallizes spontaneously in fine needles, highly double refractory. In heat there is a formation of rhomboidal tables.

Yttrium and Erbium are also recognized by means of oxalic acid and ammonium oxalate.

Titanium is attacked with potassium disulphate, and the mass is moistened with hydrogen peroxide. An orange yellow coloration shows the presence of titanium.

Zirconium.—Attack with sodium carbonate at bright redness and dissolve in acidulated water. If zirconia is present, it forms small hexagonal tablets.

Tungsten.—The substance is melted with niter, dissolved in water, and calcium chloride is added. If tungsten is present, cubes, square tablets, or bipyramidal prisms of calcium tungstate are formed.

Tantalum and Niobium.—The substance is fluxed with phosphorus salt, taken up in water, and caustic soda is added. There are formed colorless prisms of sodium tantalate or niobate, often grouped in tufts or stars.

Vanadium.—The substance is attacked with sodium carbonate and potassium nitrate, taken up in water, and a little ammonium chloride is added. There are formed navicular or cuneiform crystals of ammonium metavanadiate, double refractive.—*Bulletin des Eleves de M. Fremy* (April, 1886, p. 145); *Chem. News.*

DRIVE WELLS VS. OPEN WELLS.

AT the recent Denver meeting of the American Water Works Association, the secretary read the following question: "Is the system of drive wells practicable for pumping works as a source of supply?"

Mr. Lyman.—I would say that would depend upon the location and the distance it was driven. I know of locations in Nebraska where the drive well system is a perfect success. In the city of Grand Island they are thirty feet deep; they have an inexhaustible supply drawn from the bed of the Platte River through those wells; they have passed through the ordeal of trial tests, and have come out perfectly satisfactory. There is no limit to the amount of water drawn. In other localities, where the distance to the vein of water would be eighty feet, as in some parts of Nebraska, I don't believe they would ever amount to anything.

Mr. Richards.—A system is being built at Pensacola, Florida, with a guaranteed capacity of four million gallons per day. It has a series of pipes being driven in the ground, and connected by one common pipe to the engine.

Mr. Beach.—I have seen drive wells in a good many places, but have failed yet to see a place where it has been perfectly successful. It is done, I know, in a great many places, and the general supposition is that it is a success; but in most of the places where it has been done, there have been so many unforeseen difficulties arising in one way and another, that steps have been taken to dispense with it. Sioux City, Iowa, has such water works. That system has been cited as a perfect system of drive wells, also as a pattern to be governed by. There are a great many others. Fremont, Nebraska, has a similar system. If you go in there and talk with the engineers or with any one directly connected with the water works, and question them right down as to the success of it, you find there are a great many difficulties in the way, and that it would not be generally approved of by experienced men. I cannot see that there is anything gained in the first cost.

I would make this a question between a drive well system and an open well system. The paper that was to be read upon "Ground water as a source of supply," I am sorry to see was not presented. At Sioux City they have a system of pipes driven on a long street, ten or fifteen of various sizes. With so many joints, each joint leaking a trifle, a complication results that they get so much air it is necessary to run an independent pump to exhaust it, the expense of which is more than one-third the expense of running the pumping engine.

The point I make is this: If there is sufficient water to supply a system of drive wells, there is sufficient to supply an open well. I have put in a great many systems of open wells. I take the ground of opposing the drive well; it is not a success, it is a makeshift. These pipes have to be taken up continually and put down again. The question I ask is, Which is preferable—the drive or the open well?

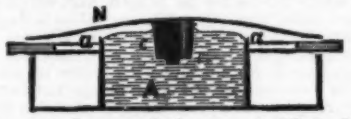
At Faribault, Minn., I put in an open well 20 feet in diameter, 19 feet deep. There were no surface indications of water within half a mile. That well is supplying the city of Faribault, of four or five thousand inhabitants. I discovered by an examination that there is a stratum of sand rock at the depth of 19 feet; on top of that stratum, gravel 11 feet deep with a stream of water; you would get a fine supply by drive wells, but just as good a supply with an open well. We pump about a million and a half of gallons in 24 hours. We find it impossible to pump that well down in the driest season, within five or six feet of the bottom.

Where the drive well can be used on account of the strata and the soil, the open well can be used with a great deal better success.

Mr. Beach.—At Faribault it was said that some of the wells had gone dry since putting in the water works, and it was attributed to an open well; but that is simply considered talk; it is not proved that it had such an effect. We had a very dry time; our inference was, their wells would have gone dry without this well. I will give you the result of some experiments in regard to it, to show it did not have that effect. We put in a drive well to try the water some 30 feet distant. We put down a well 10 feet from the large well, and another 10 feet from that, until we dug four holes, the last one 40 feet away. We pumped the water down in the large well, and held it down for some 18 hours; in the test well next to the large well, it drew it down about a foot. In the one 20 feet away, about three or four inches. In the others, the effect we could not see; conclusive evidence that it did not affect the water, except for a short distance.

GALVANOMETER NEEDLE.

I DESCRIBE a device—novel, as far as I am aware—which I have tried with success, for supporting the needle of a tangent galvanometer. A small dish, A, 1



in. diam., with sharpened edges, *a a*, is filled with clean water, and a needle, *N*, made from the hair spring of a watch, is cemented to the top of a small cylinder of cork, *c*, which is ballasted underneath with a bit of lead, as shown. The needle is set afloat in this trough, the water in which must present a slightly convex surface, and the cork must be pressed down so as to wet its sides. It will then take up a position in the center of the trough, and if there be not a film of grease on the water's surface, the needle will turn absolutely without friction or torsion either. Mercury is useless as a substitute for water, because of the film from which its surface cannot be kept free. Even water is subject to a similar difficulty, but moderate care to avoid grease and dust getting about the float or dish, and the use of clean water, or, perhaps, better still, the employment of some liquid, such as turpentine or spirit, capable of dissolving grease, will prevent trouble from this source. The dish is placed upon a shelf arranged so as to bring the needle into the center of galvanometer coils, and when the needle float is brought by the leveling screws exactly into the center of the index circle, the slightest current will deflect the needle.

Another advantage of the device is that the slightest deflection can be observed, as the needle is almost perfectly "dead beat." I can do nothing with cocoon filaments; their perpetual dancing cloaks the movement due to faint currents. With the float, etc., as described, it is easy to shift the instrument about with moderate care; but the care required can easily be diminished if a caoutchouc tube, leading to the bottom of the dish, be fitted so as to be compressed or relaxed at will by a screw, thereby elevating or depressing the surface of the water.—*R. Snowdon, Industries.*

THE INVENTOR OF THE TELEGRAPH.

A CURIOUS document has lately been restored to light, which establishes the fact beyond question that Charles Morrison, in 1753, then of Renfrew, Scotland, was the first inventor of the electric telegraph, and put the invention into actual use some time prior to that year. The following is his description of the invention, which is full, complete, and practical, as published in 1753 in the *Scots Magazine:*

AN EXPEDITIOUS METHOD OF CONVEYING INTELLIGENCE BY MEANS OF ELECTRICITY.

RENFREW, February 1, 1753.

To the author of the *Scots Magazine:*

Sir: It is well known to all who are conversant with electrical experiments, that the electric power may be propagated along a small wire, from one place to another, without being sensibly abated by the length of its progress. Let, then, a set of wires, equal in number to the letters of the alphabet, be extended horizontally between two given places parallel to one another, and each of them about an inch distant from that next to it. At every twenty yards end, let them be fixed in glass or jeweler's cement to some firm body, both to prevent them from touching the earth or any other non-electric and from breaking by their own gravity. Let the electric gun barrel be placed at right angles with the extremities of the wires, and about an inch below them. Also let the wires be fixed on a solid piece of glass, at six inches from the end; and let that part of them which reaches from the glass to the machine have sufficient spring and stiffness to recover its situation after having been brought in contact with the barrel. Close by the supporting glass, let a ball be suspended from every wire; and about a sixth or an eighth of an inch below the balls place the letters of the alphabet, marked on bits of paper or any other substance that may be light enough to rise to the electrified ball; and at the same time let it be so contrived that each of them may reassume its proper place when dropt. All things constructed as above, and the minute previously fixed, I begin the conversation with my distant friend in this manner: Having set the electrical machine a-going as in ordinary experiments, suppose I am to pronounce the word *Sir;* with a piece of glass or any other *electric per se*, I strike the wire *s* so as to bring it in contact with the barrel, then *i*, then *r*, all in the same way; and my correspondent, almost in the same instant, observes these several characters rise in order to the electrified balls at his end of the wires. Thus I spell away as long as I think fit; and my correspondent, for the sake of memory, writes the characters as they rise, and may join and read them afterward as often as he inclines. Upon a signal given or from choice, I stop the machine, and taking up the pen in my turn, I write down whatever my friend at the other end strikes out.

If anybody should think this way tiresome, let him, instead of the balls, suspend a range of bells from the roof, equal in number to the letters of the alphabet, gradually decreasing in size from the bell A to Z; and from the horizontal wires let there be another set reaching to the several bells: one, *viz.*, from the horizontal wire B to the bell B, etc. Then let him who begins the discourse bring the wires in contact with the barrel, as before, and the electrical spark, breathing on bells of different size, will inform his correspondent by the sound what wires have been touched. And thus, by some practice, they may come to understand the language of the chimes in whole words, without being put to the trouble of noting down every letter.

The same thing may be otherwise effected. Let the balls be suspended over the characters as before, but instead of bringing the ends of the horizontal wires in contact with the barrel, let a second set reach from the electrified cake, so as to be in contact with the horizontal ones; and let it be so contrived at the same time that any of them may be removed from its corresponding horizontal by the slighest touch, and may bring itself again into contact when left at liberty. This may be done by the help of a small spring and slider, or twenty other methods, which the least ingenuity will discover. In this way, the characters will always adhere to the balls, excepting when any one of the secondaries is removed from contact with its horizontal; and then the letter at the other end of the horizontal will immediately drop from its ball. But I mention this only by way of variety.

Some may perhaps think that although the electric fire has not been observed to diminish sensibly in its progress through any length of wire that has been tried hitherto, yet as that has never exceeded some thirty or forty yards, it may be resonably supposed that in a greater length it would be remarkably diminished, and probably would be entirely drained off in a few miles by the surrounding air. To prevent the objection, and save longer argument, lay over the wires from one end to the other with a thin coat of jeweler's cement. This may be done for a trifle of additional expense; and as it is an *electric per se*, will effectually secure any part of the fire from mixing with the atmosphere. I am, etc., C. M.

In 1859, Sir David Brewster disinterred this long-forgotten letter from the *Scots Magazine*, and republished it in the *North British Review.* In his remarks upon the letter he says: "Here we have an electric telegraph upward of a hundred years old, which at the present day would *convey intelligence expeditiously*, and we are constrained to admit that C. M. was the inventor of the electric telegraph. . . . Everything done since is only improvement."

But who was C. M.? From modesty or other reasons Charles Morrison had only signed his initials. Sir David Brewster was in the dark. At last light came in letters now fully given to the world for the first time. These letters, after the death of Sir David, were found among his correspondence by C. Brewster Macpherson, Esq., of Belleville House, Kingussie, and by him generously presented to the Watt Library, Greenock.

The first is a letter to Sir David from R. H. Loudan, as follows:

PORT GLASGOW, October 31, 1859.

Sir: Having the other evening been reading a portion of the *North British Review*, vol. xxii., p. 545, regarding the invention of the electric telegraph, and having by mere chance come upon the passage which says, "It was reserved for a Scotchman, a gentleman residing in Renfrew, to suggest the idea of transmitting messages by electricity along wires passing from one place to another. The remarkable proposal was published in the *Scots Magazine* for February, 1753, in an article bearing the initials 'C. M.,' *the only name which we shall ever probably obtain* for the first inventor of the electric telegraph"—a friend of mine [Mr. Foreman], at present living with me here, on being shown the passage, and thinking for a minute, told me he could solve the mystery regarding the gentleman in question, with the view of sending the same to you, presuming that you were the writer of the article referred to, or connected with the publishing of the *North British Review.* He stated that in a letter which his great-grandfather had written to Margaret Wingate, Craigengilte, near Denny, in the year 1752, which letter he recollects having seen, and which he believes is still in preservation, his great-grandfather describes having seen a gentleman in Renfrew of the name of Charles Morrison, who was a native of Greenock, and was a bred surgeon, but it *is a question whether he ever prac-*

ticed his profession, as it was known he was sometime connected with the tobacco trade in Glasgow. It is presumed he had not continued very long at the business of dealing in tobacco, but had made the study of finding out this noble science his daily theme. The people of that age were so superstitious that they believed Mr. Morrison was *crazy* and that the *devil was acting in concert with him*, and my friend's grandfather and grandmother also thought so; and all who heard or saw him transmitting intelligence along wires by invisible means were actually persuaded that the man was assisted by some supernatural being. From what my friend can remember of hearing, it is thought that Mr. Morrison had to leave Renfrew in consequence of the superstitious notions of the age. Mr. Morrison did leave Renfrew, whether from this cause or not he cannot affirm, and went to Virginia, U. S., where he afterward died.

My friend remembers perfectly well when a boy of his grandfather coming to his father's house, and telling all sorts of stories about the gentleman in Renfrew who could transmit messages along wires, and what the general opinion was regarding him. The subject being new and interesting caused him to listen to it with greater attention, and this is the reason he says why he recollects so well about Mr. M. at the present day.

Perhaps I am only troubling you with this long epistle for no use, as you may ere now have obtained from some one else a better history of Mr. M.'s pedigree.

My friend advised me to send the above information as an article for publication in the newspapers, but I thought it would be better to send the same first to you, and probably you might inform me if you had not already been favored with the intelligence, and advise whether you would wish to publish the same yourself.

If you desire any further particulars regarding Mr. Morrison, I shall be happy to be at your service, and endeavor to obtain anything you may suggest.

I have the honor to be, sir,

Your most obedient, faithful, humble servant,

R. H. LOUDAN,

At Alex. Lade, Esqr.'s.

The following statement was furnished by Mr. Foreman to Mr. Loudan, for the information of Sir David Brewster:

In answer to your inquiries respecting Charles Morrison, I now beg to inform you that I recollect of having seen a letter about thirty years ago addressed by my great-grandfather, Mr Foreman, farmer, Blackdhu, near Stirling, in Perthshire, to Miss Margate Wingate, residing at Craigengelt, near Denny (to whom he was subsequently married), and which I now fully believe was dated in 1750 (instead of 1752, as I lately stated to you), referring to a gentleman in Renfrew who transmitted messages along wires short distances by means of electricity. His letter gave the gentleman's name as Charles Morrison, and described him as being a *very bashful and eccentric individual*, a native of Greenock, and bred a surgeon. I also recollect of having seen and read a letter in the handwriting of this same Charles Morrison (it being signed by him), addressed to Mr. Foreman, dated September 25, 1752, giving a detail of his experiments in sending messages along wires by means of electricity, and stating that he had sent a description of the same to Sir Hans Sloan, in London, by whom he was encouraged to perfect his experiments, and that he intended giving him a more detailed account in the following year, 1753, when he hoped also to be able to publish a minute narration thereof in the *Scots Magazine*. His letter also stated Sir Hans Sloan at that time was an aged man, and very frail, and that it would probably be about the month of May, 1753, before he could comply with the requirements of Sir Hans; but Mr. Morrison appears to have been able to comply sooner than he expected, as the letter is dated February in the *Scots Magazine*. It also stated that as he was likely to be ridiculed by many of his own acquaintances, and as it was a thing the great world cared little about, he would only publish his initials. What causes me to recollect the date, September 25, of the above letter at this day is that I was born on that day and month.

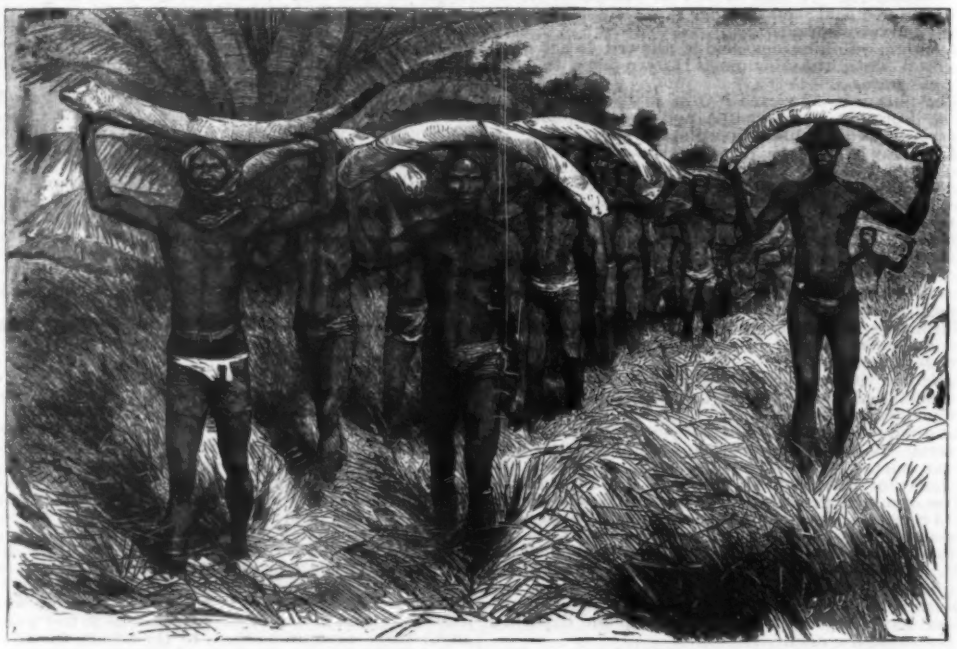
The letters above referred to I believe are still in preservation, and if I had an opportunity I would go myself and make a search for them. They are in the possession of an aunt of mine who resides near Stirling. If they have been destroyed, it must have been within the last few years, as I know she had them lying in a garret among a great number of other old papers and books.

I forgot to say that there are descendants of Margt. Wingate above referred to, of that name, who are shawl manufacturers in Glasgow, and I have no doubt if they were communicated with they might in some way or other verify the truth of the above statements.

D. W. FOREMAN.

AFRICANS CARRYING IVORY TO THE SEA COAST.

THE scene depicted represents the cumbersome transport of elephant tusks from the extensive forests situated near the small settlement of Knysna to the sea coast; thence they are shipped via Cape Town to London, and doubtless many of our readers have articles in their possession made of Knysna ivory.



AFRICANS CARRYING IVORY TO THE COAST.

Knysna is a small town 307 miles east of Cape Town, with a capital harbor, the estuary of which is a fine sheet of water ten miles in length, and varying from one to two miles in width. The entrance is flanked on either side by lofty rocks, known as Knysna Heads, 400 yards apart; and to the eastward lies the famous Zitzikama Forest, abounding with game of all kinds. The Royal Princes enjoyed a good elephant hunt here. Our engraving is from a photograph.—*London Graphic.*

A GREEK GIANT.

FROM a photograph taken by Mr. Cacoulis, we reproduce the portrait of a young Greek giant who has been attracting the attention of the public at Trebizonde. This young man, whose name is Amanab, was born near Kerassond in 1868. He is 7¾ feet in height; the circumference of his head is 26¾ inches; and the girth of his body at the chest is 4 feet and 4 inches.

Amanab, who is but 18 years of age, has perhaps not as yet reached his full development, and it is not impossible that he may grow still taller. He has no occupation. It is his intention to visit the principal cities of Europe, and exhibit himself to the public.

Amanab, notwithstanding his great size, has not yet reached that of certain giants to whom attention has been called at various epochs. If Buffon is to be believed, there have been giants who exceeded 8½ feet in height; but the fact has never been authenticated.

In 1795, there was exhibited at Paris a giant who was 6 feet 8 inches and 8 lines in height. It will be seen that such height was much less than that of Amanab. This giant was born in Finland, upon the confines of Southern Lapland. The giant of Thoresby, England, was 7 feet and 5 inches in height.

The Duke of Wurtemberg had a porter who was 7½ feet in height.

A very remarkable Chinese giant named Chang was exhibited at Paris a few years ago. He was larger than the Greek under consideration, his height being 8 feet; and, unlike his similars, he was intelligent and educated and spoke several languages.

It will be seen from what precedes, that the Greek Amanab, despite his respectable height, is far from being without a parallel; but he much exceeds some men already exhibited as having a prodigious stature. He singularly exceeds men of medium stature, as shown in the engraving. It will be seen that a chair is not much higher than his knee.—*La Nature.*

AMANAB, THE GREEK GIANT.

IMPROVING THE COMMON FISH POLE.

A BIRCH, alder, or willow pole can be much improved at a trifling expense. First cut the pole into two, three, or four pieces. Remove the bark at the ends, forming a round tenon on each, as in Fig. 1. Have the tinsmith make a tin ferrule to fit each end. These ferrules, if used single, must be from four to six inches long, so that each end will have a deep socket. Fasten the ferrules on the upper end of each piece securely. A tip for the pole can be made of any tough, springy wood, to replace the natural tip if so desired, and can be completed with a wire loop at the smaller end, and wire stays for holding the line, as shown in the engraving. When fishing along brooks, where it is frequently necessary to lengthen or take up the line, a reel will be found very useful. One that will answer for a common fish pole is shown in Fig. 2. This can be made from a common spool, a piece of wire, and a piece of thick tin. The tin may be cut in the form of a cross, the longest part bent rounding, so as to fit the butt of the pole, the sides bent up so as to support the spool, which is to be placed in position with the wire crank inserted. The reel thus made can be secured to the pole, as shown in Fig. 1, with twine.

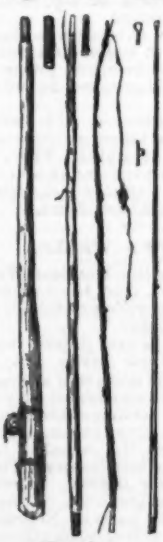


FIG. 1.

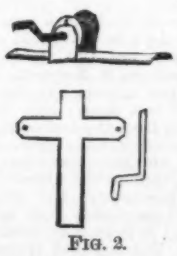


FIG. 2.

IT is reported that a volcano on Islas Blancas, off the Pacific coast, is in full eruption, emitting a column of flame and smoke 100 feet in diameter.

ON VEGETABLE DIET AND ON FATTY FOODS.*

By Professor DUJARDIN-BEAUMETZ, Paris, France.

GENTLEMEN: If man claims a variety of aliments from the animal kingdom, equally important are those furnished by the vegetable kingdom. Considered as a whole, these vegetal foods contain as elements suitable for nutrition: 1, certain albuminoid substances, gluten, vegetable albumen, casein, legumen, and fibrin; 2, starch; 3, dextrine and glucose; 4, fatty matters; 5, salts and water.

Foods thus constituted become complete aliments, *i. e.*, aliments which contain all the primordial elements necessary for nutrition; only, the vegetal proteids, the salts, and the fatty matters are in quantity insufficient to sustain life, at least in man, while, on the other hand, sufficient for the herbivora. The word *insufficient* is not even altogether applicable to man, for there are whole populations that are strictly vegetarian. In order, however, fully to meet the requirements of the economy, a great quantity of vegetable aliments must be ingested to supply the twenty grains of nitrogen which a man loses daily.

The advantages of an exclusively vegetable diet have been latterly much overrated. We have heard it affirmed that by perseverance in such a diet man might successfully resist most diseases, and attain to a great age; this is the doctrine of vegetarians. While recognizing the great benefits which may be derived from a purely vegetable diet in certain affections of the stomach, I believe that man, by his anatomical and physiological constitution, is omnivorous, enjoying the fullest possession of his powers on a mixed diet. On this subject I shall hereafter have more to say.

The albuminoid principles of vegetables have been well studied by Ritthausen. They consist of vegetable albumen, casein, legumen, gelatin, gluten, and congluten. As for gluten, its composition is very complex, and Ritthausen affirms that it is made up of at least four albuminoid substances—gluten-casein, insoluble in alcohol, and three substances soluble in alcohol—gluten-fibrin, gliadine, and mucedine.

I give you here from Ritthausen the ultimate analysis of these vegetable albuminoid substances, as obtained from various cereals and legumes:

	Wheat.	Barley.	Indian corn.	Lupines.	Peas.	Beans.
Carbon	53·12	52·86	52·31	52·63	52·94	53·33
Hydrogen	7·18	7·23	7·73	7·46	7·13	7·19
Nitrogen	17·60	15·75	15·49	17·24	17·14	17·14
Sulphur	1·55	1·18	.....	0·76	1·04	1·04
Oxygen	20·55	22·98	.....	21·91	21·75	21·75

If you glance over the following table, which gives the proximate composition of our principal amylaceous foods, you cannot fail to observe that in general the amount of starch is in inverse proportion to that of the azotized matters:

RITTHAUSEN'S TABLE OF THE COMPOSITION OF AMYLACEOUS ALIMENTS.

Substances.	Azotized matters.	Starch.	Dextrine and Glucose.	Fats.	Cellulose.	Salts.	Water.	Authorities.
Wheat	20·68	62·49	8·36	2·32	3·02	2·86	....	Payen.
Rye	9·00	57·50	10·00	2·00	3·00	1·90	14·60	Boussingault.
Oats	11·90	53·68	7·90	5·50	4·10	3·00	14·00	
Barley	12·96	66·43	10·00	2·76	4·73	2·10	....	Payen.
Bread crumbs	6·67	53·55	3·79	0·70	....	0·84	44·45	Violet.
Bread crust	13·00	62·58	3·88	1·18	....	1·21	17·15	
Army bread	8·85	44·50	4·12	0·70	6·07	1·39	34·17	Poggiale.
Indian corn	12·80	58·40	1·50	7·00	1·50	1·10	17·70	Boussingault.
Rice	6·43	77·75	0·60	0·43	0·50	0·68	14·40	
Potatoes	2·05	20·00	1·09	0·11	1·04	1·26	74·00	Payen.
Horse bean (Faba equina)	30·80	48·00		1·90	3·00	3·50	12·50	
Vetches	27·30	48·90		2·70	3·50	3·00	14·60	
French bean	25·50	55·10		2·80	2·90	3·20	9·90	
Lentils	25·20	56·00		2·60	2·40	2·30	11·50	
Peas	23·80	58·80		2·10	3·50	2·10	9·80	
English bean	24·40	61·50		1·50	3·00	3·60	16·00	

In the vegetable alimentation, starch and the amylaceous principles play an important part. You know that they are absorbed in the state of glucose, and that the transformation of starch into glucose is the result of two ferments—the one, the product of mixed saliva, is the salivary diastase; the other, which belongs to pancreatic juice, is amylopsin.

The transformation of starch into sugar is not as simple as one might imagine at first sight. The supposed breaking up of the starch molecule into one molecule of dextrine and one of grape sugar is not a representation of the reality, if we may trust the experiments of Musculus, of O'Sullivan, of Brown and Heron, and of William Roberts.

According to these experimenters, we must consider this reaction as much more complex, and as terminating by the formation of maltose and achro-dextrine, as the following formula shows:

$$10(C_{12}H_{20}O_{10}) + 8H_2O = 8(C_{12}H_{22}O_{11}) + 3(C_{12}H_{22}O_{11}).$$
Soluble starch. Water. Maltose. Achro-dextrine.

Ewald, of Berlin, has recently studied the influence which saliva exercises upon the saccharification of amylaceous matters in the stomach. He has shown that the transformation of starch into sugar is effected to a very trifling extent in the stomach, and that after the administration of a concentrated decoction of starch you may note the presence of fermentable dextrine and maltose, but that the metamorphosis of maltose into sugar takes place only in the intestine. If to the facts attested by Ewald we add that the pancreatic juice furnishes a ferment adapted to the digestion of amylaceous matters, we are warranted in the conclusion that starchy substances are exclusively digested in the intestine.

There is always an interest in knowing (and this especially with reference to the treatment of certain affections, and glycosuria in particular) the quantity of starch contained in cereals as vegetables. The following table from Nedats gives the percentage of starch in wheat, rye, potatoes, etc.:

	Per cent.
Rice	74·10
Indian corn	65·90
Wheat flour	63·00
Whole wheat	59·60
Rye flour	59·84
Millet	59·90
Buckwheat	50·00
Wheat bread	42·70
Oatmeal	39·10
Peas	37·00
Rye bread	36·25
Beans	36·00
Jerusalem artichokes	16·60
Potatoes	15·50

We will now study successively cereals, legumes, and fruits.

The cereals serve as the basis of the principal food, the universal food, of man—bread. Without entering here into the details and complex chemical reactions of bread making, I must call your attention to the nutritive value of bread. In this respect it is important to distinguish the crust from the crumb; the crust is much the more nutritious, as the following analysis by Barral shows:

Water.	Crust.	Crumb.
Water	17·15	44·45
Insoluble azotized matters (gluten, etc.)	7·30	5·92
Soluble azotized matters (albumen and the like)	5·70	0·75
Soluble non-azotized matters (dextrine, sugar)	4·88	3·79
Starch	62·58	43·55
Fatty matters	1·18	0·70
Mineral matters	1·21	0·84
	100·00	100·00

It is generally believed also that bread made from the coarser, inferior flours is more nutritious than bread made from superfine flour. This is a mistake, and Violet has shown us that the finer and whiter the flour, the more nitrogen it contains. This is Violet's table:

	Percentage of nitrogen.		
	Second quality.	First quality.	Superfine.
First sample	0·92	1·18	1·39
Second sample	1·05	1·36	2·06
Third sample	0·99	1·02	1·25
Average	0·99	1·15	1·57

Nevertheless, in placing ourselves on a somewhat different standpoint, and in judging the nutritive value of bread, not by the quantity of nitrogen which it contains, but by that of its saline principles, bread made from flour that is incompletely bolted possesses certain advantages.

You know, in fact, that the husks of grains are especially rich in phosphates. Hence it has been recommended in certain cases, where it is desired to introduce phosphates into the economy, to give bran bread. When I come to speak of the dietetic treatment of diabetes, I shall show you by what artifices ordinary bread has been replaced by bran bread or, better still, by gluten bread.

Rye, Indian corn, buckwheat, and even oats have been substituted for wheat in the fabrication of bread. Two of these deserve special mention. Corn bread is exceedingly nutritious. Corn meal contains a larger proportion of fatty matters than the flour of any other cereal. Hence it is that corn bread occupies a large place in the dietary of certain peoples, especially in regions where wheat cannot be raised. It has, however, a peculiar taste, which renders it repugnant to most persons, at least till they become accustomed to it. Oatmeal has been highly vaunted by the Scotch physicians, who claim that the fine physical development of that nation is due to the fact that they are reared on oatmeal. In a work undertaken by me, in conjunction with Ernest Hardy, I have shown the large proportion of nitrogen contained in oatmeal. The following analysis, published by ourselves, will make this plain:

Water	8·7
Fatty matters	7·5
Starch	64·0
Azotized matters, gluten	11·7
Mineral matters	1·5
Cellulose, and other matters not determined	6·6
	100·0

Hence it is that in the feeding of horses, oats, by reason of their richness in nitrogen, have been considered the force-giving aliment *par excellence*. Add to this that oats contain a particular excitant principle, which Sanson has isolated, and the effects of which he has studied. This excitant principle is found especially in black oats, and its effects on the horse last, on an average, for an hour after giving a quart of oats. The large percentage of iron in oats is also worthy of note.

This double quality of being a strengthening and excitant aliment renders oatmeal suitable for the dietary of children, and you will find in the thesis of my pupil Marie* interesting facts relative to this subject. I believe even that we might to-day complete our researches by studying on man, as Sanson has done on horses, the effects of the excitant principle, which he has isolated, and seeing if it may be utilized in therapeutics.†

Vegetables are divided into starchy and herbaceous. Starchy vegetables (legumes, *i. e.*, beans, peas, lentils) contain a great quantity of legumine, and for this reason are very nutritious. Hence it is that beans have been called the *poor man's meat*. The following analysis is from Boussingault:

COMPOSITION OF SEEDS OF THE LEGUMINOSÆ.

	White beans.	Peas.	Lentils.	English beans.
Legumine	26·9	23·9	25·0	24·4
Starch and dextrine	48·8	59 6	55·7	51·5
Oily substance	3 0	2·0	2·5	1·5
Lignine and cellulose	2·8	3·6	2·1	3·0
Salts	3·5	2·0	2·2	3·6
Water	15 0	8·9	12·5	16 0
	100·0	100·0	100·0	100·0

The husk which covers these seeds is composed exclusively of cellulose, which renders them somewhat indigestible. So when you have to do with weak stomachs or persons who masticate imperfectly, you should direct them to eat their beans or peas hulled, and boiled into a mash or soup.

Among these legumes I must call your attention to lentils, which deserve especial mention from the point of view of their nutritive value, being not only rich in azotized matters, but also containing much iron.

Boussingault, who has given us a very instructive analysis of different aliments with respect to the iron which they contain, has assigned the first place to lentils; in fact, the proportion of this metal in lentils is double that which is found in beef, although surpassed by oats:

	Quantity of iron in 1,000 parts.
Beef's blood	0·03750
Blood of swine	0·06340
Muscle of beef	0·00480
Muscle of veal	0·00270
Muscle of fish (Merlan)	0·00150
Fresh codfish	0·00420
Hens' eggs (without the shell)	0·00570
Snails	0·00360
Beef bones	0·01200
Sheep's foot	0·02090
Wheat bread	0·00480
White beans	0·00740
Oats	0·01310
Lentils	0·00830
Potatoes	0·00160
Cow's milk	0·00180
Carrots	0·00090
Indian corn	0·00360
Rice	0·00150
Apples	0·00300
Spinach	0·00450
Cabbage	0·00390
Red wine of Beaujolais	0·01090
Beer	0·00400
Seine water	0·00104

But do not forget that in order that lentil flour may possess all its properties it must be cooked, and it is in this form that you should prescribe it for your patients. It is quite probable that the sweet revalesciere (a patent farinaceous preparation common in France), and which has been so much advertised, is composed in part of malted lentil flour.

By the side of these starchy vegetables, and at their head, should be placed potatoes, an aliment to-day quite as indispensable as bread. You have seen by a foregoing table how small the proportion of starch contained in potatoes, and in this respect this vegetable occupies a low place; hence the applicability of potatoes to the dietary of diabetes.

The herbaceous vegetables may be divided into three great groups—vegetables rich in vegetal albumen and in nitrogen, such as cabbages, water cresses, asparagus, mushrooms, truffles; then mucilaginous and saline vegetables, such as lettuce and chiccory; lastly, vegetables rich in acids, such as sorrel and tomatoes. Let us glance over these three groups.

The first comprises those vegetables which are most nutritious, but whose digestion is at the same time the most difficult. Leven maintains that cabbage is very hurtful to the stomach. I canot agree with him, and regard cabbage as an excellent aliment, highly azotized, which is well digested when sufficiently cooked.

I will say a few words about mushrooms. Despite the large quantity of water which enters into their composition—eighty-five to ninety per cent.—they contain considerable nitrogen, and for this reason are nutritious. Carl Woerner, of Upsal, who has recently studied the alimentary value of mushrooms, has shown that a kilogramme of beef has for equivalent:

	Kilogrammes.
In edible mushrooms (Agaricus esculentus)	9 30
In oyster mushrooms (Agaricus ostreatus)	10·60
In morilla (Morchella esculenta)	15·20
In chanterelle mushrooms (Chanterellus cebarius)	41·60

The second class contains the mucilaginous and saline vegetables, and includes chiccory, lettuce, spinach, artichokes, celery, string-beans, asparagus, green peas,

* A lecture on Hygienic Therapeutics, delivered in Cochin Hospital.

* Marie, "A Study on the Employment of Oatmeal" (*Thèse de Paris*, 1873).

† Sanson, "Experimental Researches on the Excitant Action of Oats" (*Jour. d. Anat. et de Phys. de Ch.*, Robin et Pouchet, t. xix., 1883, p. 113).

carrots, beets, and pumpkins. These are the aqueous vegetables, and the quantity of water which most of them contain is represented in the following formula:

	Per cent.
Cucumbers	96·2
Asparagus	92·2
Spinach	91·7
Cabbage	87·7
Turnips	87·0
Carrots	87·5
Turnip-cabbages	82 0
Artichokes	76 0
Jerusalem artichokes	76·0

Certain of these vegetables contain also inosite or sugar, as the beet and carrot. The greater number are rich in salts, such as malates and oxalates of lime or potassium. This richness of vegetables in potassium is one of the most interesting points connected with their composition, and shows their utility in nutrition. Boussingault has given a good analysis of vegetables with respect to the quantity of potassium which enters into their composition. One kilogramme of the following vegetables contain the amount of potassium here given:

	Grammes.
Cabbage	2·6
Chicory	1·7
Turnips	3·7
Carrots	2·5
Beets	6·8
Potatoes	3·2
Spinach	4·5

Hence Beunge has insisted on the necessity of introducing into the dietary of individuals who subsist largely on vegetables common salt, in order to maintain a constant equilibrium between the salts of potassium and sodium, an equilibrium which is essential to a healthy nutrition.

The last group is constituted by vegetables rich in acid, and particularly in oxalic acid. We have here sorrel and the tomato, which, when eaten too freely, may give rise to oxaluria. There has been much discussion respecting this physiological oxaluria, some pretending that it may be brought about independently of alimentation, others that it is always of alimentary origin. While believing that the latter view is the correct one, I shall reserve what I have to say on this subject till I come to speak of the diet of urinary gravel, and in particular of oxalic acid gravel. It remains to finish what pertains to vegetable foods by speaking of fruits.

Fruits complete the alimentation of man by the acids, the salts, and the sugar which they contain. Their general composition is very complex; besides sugar, salts, and acids, gum, cellulose, and a small proportion of azotized matter enter into their composition. The following is Berard's analysis:

ANALYSIS OF RIPE FRUITS (BERARD, 1821).

	Apricots.	Peaches.	Pears.	Cherries.	Prunes.
Azotized matters	0·17	0·98	0·21	0·57	0·28
Coloring matters	0·10 (Yellow.)	—	0·01 (Green.)	—	0·08 (Green.)
Cellulose	1·86	1·21	2·19	1·12	1·11
Gum	5·13	4·85	2·07	5·38	2·06
Sugar	16·48	11·61	11·52	18·12	24·81
Malic acid	1·80	1·10	0·08	2·01	0·56
Lime	Traces.	0·08	0·04	0·10	Traces.
Water	74·67	80·24	83·86	74·85	71·10
	100·00	100·00	100·00	100·00	100·00

The acids contained in fruits are very variable. Thus, peaches, apricots, apples, pears, and currants contain malic acid; grapes, tartaric acid; oranges and lemons, citric acid; quinces, pectic acid; the latter, by undergoing transformation into pectine, enables us to make jelly of this fruit.

Like vegetables, fruits introduce into the economy alkaline principles, such as lime and potassium; they are then useful foods. By the sugar which they contain they serve also for nutrition, but when eaten too freely they become purgative.

I ought especially to call your attention to grapes, from which therapeutics has derived such great advantage in the treatment of certain affections, a kind of treatment known under the name of *grape cure*. Very much in vogue in certain parts of Switzerland and Germany, and now employed in France, this mode of treatment is particularly applicable to gastro-intestinal affections. It has proved of service in abdominal plethora, and paretic conditions of the alimentary canal from high living or overeating. If we may trust Carriere and Curchod, the grape cure is also an efficacious means for combating diarrhœic fluxes and certain diathetic states, as gout.*

These are the principal rules to follow: You will direct the patient to eat before his meals a certain quantity of grapes, which he must himself gather from the vines, and which should be eaten while being gathered. I say a certain quantity, for it is impossible to say exactly how much each patient should eat. He ought, however, to eat to complete satiety, for the benefit is largely due to an excess being ingested. As for the kind of grapes to choose, the best is the white grape with fine skin and delicate pulp. The skins must, of course, be rejected, and the seeds, if possible. As is the case with the whey cure system, there are two important factors in the causation of the good results obtained from the grape cure. The fruit itself by the saline elements which it introduces acts favorably on the surface of the digestive tube, and the sojourn (with active exercise) in the open air has an invigorating effect. It is, in fact, in the midst of the most beautiful scenery of Germany, Switzerland, Silesia, and the Tyrol that the grape cure is carried out. This completes what I have to say about vegetable foods, and I pass on to the consideration of fatty foods.

The fatty aliments consist of butter, fats, and oils. When I was on the subject of primordial alimentary principles, I reminded you of the importance of these fatty aliments in nutrition. Not only do they furnish to the economy the hydrocarbonaceous materials which it needs, but they oppose, in a certain measure, if we may trust the experiments of Debove and Flamant, the destruction of albuminoid elements, so that we may consider them as *sparing* aliments (*aliments d'epargne*). If their nutritive value is great, their digestibility is feeble; hence it is that these fatty foods quite often prove to be the most indigestible, and when eaten in moderation they are a source of irritation and discomfort in the digestive tube, and if taken in considerable quantity they become real cathartics, constituting what has been described under the name of oily purgatives.

All these fatty substances are of vegetable or animal origin, constituting the fixed oils or fats. We may even add a third group, the mineral fatty bodies, such as vaseline, a product of petroleum, and which, by a curious artificial process of refinement (as Riche has lately shown) has become an article of food. It has, however, been shown by experiments on animals that if vaseline be not toxic it does not possess any nutritive properties.

Among these fatty bodies there is one which plays a considerable *role* in therapeutics. I refer to cod-liver oil. From time immemorial among the maritime populations of the extreme North—in Iceland, in Greenland, in Norway—cod-liver oil has not only formed an important article of food, but has been applied to medical uses, special curative virtues having been attributed to it in rheumatism, neuralgia, and consumption. Percival and Darbey, at the end of the last century, called the attention of physicians to these remedial properties, but it was not till 1822, and consecutive to the work of Schenck, that the employment of this oil became general, and in France its speedy popularity was due to the labors of Bretonneau and Ducios.

To-day everybody is agreed in ascribing to cod-liver oil physiological properties clearly defined, and which consist especially in an increase of the weight of individuals to whom this oil is administered. We have here one of the results, the best demonstrated of late years, as you will see by the monograph of Rendu, of Lyons, which shows that in promoting increase of weight and fattening in the tuberculous, cod-liver oil is vastly superior to arsenic.*

Since Hoffer, of Lorme, found iodine in cod-liver oil, there has been a disposition to attribute to this metalloid, as well as to the bromine, sulphur, and phosphorus which the oil contains, the curative action which it possesses. I believe that this is a mistake, and I am persuaded that it is for the most part as fatty substances that these oils do good in the treatment of tuberculosis; and if I insist on this point, it is because the attempt has been made to substitute for cod-liver oil certain iodized oils, which are far from having the same effects.

The question has been often asked, What kinds of cod-liver oil are the best? Shall we give the preference to the pale over the brown oils? I do not think that there is now any doubt as to the answer which should be given to this question, and almost everybody is agreed that the pale oils, known as *virgin oils*, are better tolerated by the stomach than the brown oils, and are more palatable, while being of equal therapeutic value.

Moreover, the fabrication of these cod-liver oils has undergone great improvement, and to-day, with the exception of oleum morrhuæ of Berthe, which is still made in Paris, all the other oils are manufactured at the fishing stations in Sweden and Norway. Instead of making use of livers that have undergone partial decomposition, as was the custom formerly, only fresh livers are now used. These are thoroughly heated over a sea bath and subjected to pressure. It is, then, the fresh virgin oil which you should always prescribe. The following analysis gives you the composition of these different oils:

	Cod-liver oil.				
	White.	Amber colored.	Pale yellow.	Brown.	Dark brown.
Oleine	988·700	988·675	988·695	987·449	988·957
Margarine	8·000	8·036	8·089	9·264	8·223
Chlorine	1·122	1·122	1·176	1·018	1·005
Iodine	0·097	0·327	0·328	0·310	0·201
Bromine	0·043	0·043	0·030	0·031	0·016
Sulphur	3·201	0·200	0·196	0·156	0·142
Phosphorus	0·208	0·304	0·200	0·196	0·976
Acids	0·000	0·439	0·897	0·994	0·888
Loss	1·344	0·924	0·449	0·102	0·487
	1000·000	1000·000	1000·000	1000·000	1000·000

There has been some dispute as to whether it would do to substitute for cod-liver oil, oil obtained from other fishes, such as the skate and dog-fish. By referring to the comparative analysis of Delattre, you will see that the oils of the livers of the ray and the dog-fish are almost identical in composition with cod-liver oil:

	Cod-liver oil.	Ray-liver oil.	Dog-fish liver oil.
Oleine	988·700	986·945	987·114
Margarine	8·060	11·017	10·121
Chlorine	1·223	1·135	1·018
Iodine	0·327	0·105	0·345
Bromine	0·043	0·039	0·034
Sulphur	0·201	0·165	0·160
Phosphorus	0·203	0·286	0·206
Loss	1·344	0·338	0·942
	1000·000	1000·000	1000·000

I do not propose here to enter into the detail of the administration of cod-liver oil. A multitude of processes have been devised, which belong rather to pharmacy than to dietetics. There are, however, two points pertaining to the latter to which I desire to call your attention.

First, I cannot too much urge the importance of giving cod-liver oil at meal time, for when mixed with the whole mass of the food, and at the moment of the digestive process, these oils are better supported than when given on an empty stomach. Some have even gone so far as to recommend the incorporation of cod-liver oil with bread, but this combination is far from being palatable, and those who have used it have soon taken a disgust to both cod-liver oil and bread. The only association which seems to me a happy one is that which consists in the union of cod-liver oil with sardines, the latter oil being used instead of the oil in which sardines are ordinarily preserved.

You know also that the instrument makers have devised spoons tapering toward the end, which enable you almost to pour the oil into the throats of your patients, and thus avoid the disagreeable taste which cod-liver oil leaves in the buccal cavity. Habit, moreover, has a good deal to do with the repugnance which persons have to taking cod-liver oil, and while the people of the North relish it, the inhabitants of Central Europe find it very disagreeable. But it is a fact that children generally imbibe the oil with willingness, and, when the habit of taking it is formed, with avidity.

I advise you to discard all those pharmaceutical emulsions which have been devised to mask the taste of cod-liver oil. There are two of these mixtures, nevertheless, which deserve to remain, as they associate with the oil principles which are of use in the treatment of scrofula and tuberculosis. I refer to the preparations of oleum morrhuæ with iodoform and eucalyptol. The first, highly recommended by Fonssagrives, has the following formula:

℞ Pale ol. morrhuæ, 100 grms. (ℨ iiiss.);
Iodoform, 0·25 grm. (3½ grs.);
Essential oil of anise, gtt. x. M.

The preparation with eucalyptol is as follows:

℞ Pale cod-liver oil, 100 parts;
Eucalyptol, 1 part. M.

As for the dose of cod-liver oil and the quantity to be administered daily, this is very variable. Jaccoud, who is one of the most strenuous advocates of this remedial agent in the treatment of tuberculosis, has gone as far as 300 grms. (or about 10 ounces) per day. This is very large dosing, and few stomachs can bear anything like this quantity. Generally one is obliged to be satisfied with the moderate dose of a tablespoonful after each meal.

My regretted master, Behier, had an instinctive horror of cod-liver oil, and would never prescribe it. As a substitute, he recommended butter. Butter is, in fact, an excellent aliment, but very inferior as a fatty principle to fish oils.

Butter is constituted, as you know, of those oil-corpuscles which are in suspension in milk. It contains 83·35 per cent. of pure butter and 16·25 of buttermilk. The composition of butter is very complex. What especially characterizes it is a sweet oil formed of a mixture of oleine and butyrine. Butyrine, in contact with air, undergoes transformation into butyric acid, which gives to rancid butter its disagreeable taste and smell. Bromeis has completed the analysis of Chevreul, and gives the following as the composition of good butter:

	Per cent.
Margarine	68
Butroleine	30
Butyrine, caproine, and caprine	2

Butter is an excellent fatty aliment, the usage of which you will do well to recommend to feeble and emaciated persons. It enters into several pharmaceutical preparations. It is made the basis of several ophthalmic salves, such as the pomade of Regent, the pomade of Benedict, the pomade of St. Andre of Bordeaux. These preparations ought every one of them to be now abandoned, for the tendency of butter to become rancid makes it a bad excipient, and the unalterable mineral fats are far preferable.

Under the name of *bromo-iodized butter*, Trousseau proposed the following mixture, which he designed to replace cod-liver oil:

℞ Iodide of potassium, 0·05 grm.;
Bromide of potassium, 0·20 grm.;
Chloride of sodium, 2 grms.;
Fresh butter, 125 grms. M.
S.—To be spread on bread like butter.

I have, however, very little faith in any of these substitutes for cod-liver oil.

As intermediate between butter and milk should be mentioned cream, which has been vaunted in the treatment of certain consumptive affections and gastro-intestinal disorders. The following is Hasson's analysis of cream:

Butter	20	and sometimes	30	per cent,	
Caseine	29	"	"	11	"
Serum	51	"	"	59	"
	100			100	

Cream is, then, a mixture of butter, caseine, and serum. It is easily borne by weak stomachs, and doubtless sometimes renders service where other fats cannot be tolerated.—*Therapeutic Gazette.*

BACTERIA.

DR. PAVY, F.R.S., delivered the Harveian Oration at the Royal College of Physicians in October last. After giving the directions marked out by the founder of the oration, viz., to commemorate the benefactions that have fallen into the possession of the College, and to search and study out the secrets of Nature by way of experiment, the orator alluded to the augumentation which the income from the endowment of the Croomian Lectureship has recently undergone, by which the amount available is raised from 10*l.* to 200*l.* per annum; and to the sum (2,000*l.*) bequeathed by the late Dr. Gavin Milroy. He next spoke of the course pursued by Harvey as set forth by Lord Bacon in his "Novum Organum," or "true directions concerning the interpretation of nature." Instead of giving himself up, as others had done before him, to arguing out conclusions from accepted axioms, Harvey struck out, Dr. Pavy continued, into the hitherto untrodden path of inquiry—that of induction—and sought knowledge by a direct appeal to nature through the medium of observation and experiment. "It were disgraceful," he says, "with this most spacious and admirable realm of nature before us, did we take the reports of others upon trust, and go on coining crude problems out of these, and on them hanging knotty and captious and petty disputations. Nature is herself to be addressed, the paths she shows us are to be boldly trodden."

In the discovery of the circulation, Harvey applied the principles of induction, and argued upon them in a strictly logical way. He showed himself to be a good and careful observer, judged even by the standard set forth by John Stuart Mill on the process of observing. The experiments which Harvey conducted on the arteries and veins, to assist him in his inquiry, were founded upon a well-devised plan. Dr. Pavy next spoke of the new departure in physiology which Harvey's discovery established, of the opposition with which his views were received, and remarked that the high position in his profession he had attained did not suffice to secure

* Carriere, Grape Cure in Switzerland in the Treatment of Chronic Diseases; Curchod, Theoretical and Practical Treatise on Grape Cure. Vevay, 1860.

* Joanny Rendu, Experimental and Comparative Study of Arsenic and Cod-Liver Oil in the Treatment of Pulmonary Phthisis. Lyons, 1878.

his escape from the effect of the prejudice against innovation entertained by the multitude. Aubrey tells us he had "heard him say that after his book on the circulation of the blood came out, he fell mightily in his practice; 'twas believed by the vulgar that he was crack-brained, and all the physitians were against him."

Harvey lived, however, to see his doctrine generally accepted. The orator next referred to one issue of research derived, he said, from the labors of the present day, which has already yielded much good and useful fruit and gives promise of yielding much more. "Belonging to the realm of living nature there are," he continued, "small organisms, the existence of which we must have remained unconscious of in the absence of the aid of the microscope. These bodies are known by the name of bacteria or bacilli, and, while some difference of opinion has existed, it is generally thought that they are organisms belonging to the vegetable kingdom. There is nothing in their appearance to strike the observer that they possess any significance, and yet by recent research it has been found that they play a most important part as constituents of the living world."

The experiments of Spallanzani, Schulze, and Swann were next described by Dr. Pavy, the natural conclusion to be drawn from which, he said, "goes far toward absolutely establishing that the air contains the germs of living organisms, and that it is these that constitute the source of the microscopic organisms found to become developed in the presence of organic matter, which some have contended take rise spontaneously. This view is supported by the researches of the present day, and nothing that would bear the scrutiny of strict investigation has ever been adduced against it. It stands at the foundation of our modern notions regarding the *role* played by bacilli, and thus occupies a position of weighty importance with reference to the matter. The step from the action exerted by bacteria as agents exciting the decomposition of organic products to that which brings them before us as a source of disease is not a large one. In the one case they lead to change which would not otherwise occur, and in the other they disturb the order of changes naturally taking place, and thus induce an abnormal state; and although there is nothing in their morphological characters to show the reason, different trains of phenomena—in other words, different diseases—are occasioned by different kinds of bacilli. . . . Through the indefatigable researches of Pasteur and others, the distinguishing form and life history of certain of these organisms have been clearly made out. Placed under suitable conditions, it has been found that they can be reared or cultivated artificially, and one of the most marked and important characters belonging to them is the enormous extent of self-propagating power they possess. This accounts for the rapid spread that is observed to take place of an infectious disease, if allowed to progress without controlling measures being brought to bear upon it. We have to deal, then, with something that lives and grows by virtue of a power pertaining to itself. Permit this living growth—this parasite, in fact—to become dispersed and to enter the system of a living person, and presuming it has lodged upon a soil supplying suitable conditions for its development, it will thrive and multiply, and give rise to a series of phenomena which the physician has no power to arrest. Once the bacillus is implanted and the disease established, all that the physician can do is to see that the patient has fair play—that he is kept under the most favorable conditions for battling successfully against his enemy. What is to be philosophically aimed at, however, is to check the spread, to bar the transmission of the parasite from one person to another, by attacking it outside the body; and this, with the application of the proper measures of disinfection, can with facility be done, but naturally the facility of preventing extension stands in proportion to the degree of limitation at the time existing. The spark of fire is with the greatest ease extinguished, but let it kindle into flame, and in proportion as the flame spreads, the difficulty becomes greater to get the conflagration under. This is one way in which the attack upon the bacillus may be made, and the ravages of disease restrained. Another way, by quite a different line of tactics, presents itself; and the knowledge of this is due to the researches that have been recently conducted. The vulnerable point to which I am alluding lies, not in connection with the bacillus itself, but with the condition of the medium upon which it may chance to fall. It has been found that the parasite requires virgin soil for its growth. This observation stands in harmony with the result of common experience as regards disposition to contract infectious disease.

It has been from remote times generally known that a person who has passed through one attack of an infectious disorder is not liable to the same extent as before to become affected on exposure to contagion. An influence has been exerted giving rise to more or less protection being afforded against a recurrence of the disease. Now, it happens that by certain means the bacillus may be brought into such a weakened state as only to occasion, when introduced into the system of an animal, an effect of a mild nature, not dangerous to life, instead of the ordinary form of disease; but the effect produced—and this is the great point of practical importance—is as protective against subsequent attack as the fully developed disease. There are two methods by which attenuation in virulence of the disease-producing organism may be brought about—by conducting their artificial cultivation in a particular way, and by transmission through the system of an animal differing in nature from that in which the disease naturally occurs.

When the chain of discoveries reached the point of showing that bacilli could be reared outside the body in an artificial soil or cultivating medium, a great advance was made toward obtaining a full knowledge about them, as it placed the observer in a more favorable position for the successful prosecution of research by enabling him to vary and control his conditions in a manner that could not otherwise have been effected. Although much has been accomplished, it must be said much still remains to be done. In the case of a few bacilli, the life history has been pretty clearly made out.

Cultivated in a certain way, they retain their virulence, no matter through how many successions they pass. The last product in a series of successive cultivations is as virulent as the parent stock. By modifying the conditions under which the cultivation is carried on, the successive products of descent may be gradually weakened until they become harmless. Such being the case, any desired degree of attenuation may be obtained; and by inoculation with a virus brought down to the proper strength, the non-fatal affection may be occasioned which gives immunity from subsequent liability to take the disease under exposure to contagion. The knowledge thus acquired has been already practically turned to account upon a large scale for checking the ravages of that exceedingly fatal disease among cattle known as anthrax, or splenic fever, and through the success attained much sacrifice of life has been averted.

If this can be accomplished for one disease—and more than one can be mentioned—is there not ground for believing that means will be found for placing others of the class in the same position? Attempts are being made in this direction. All eyes throughout the civilized world are, indeed, at the present moment fixed upon the work of Pasteur in Paris with reference to hydrophobia. It would be a great achievement for this frightful disease to be brought under subjection, and certainly the results that have been obtained appear to give hopes that an approach to something of this kind has been arrived at. Looking at the nature of the disease, there is nothing inconsistent with its being dependent upon a bacillus, or microbe, as Pasteur calls it.

On the contrary, owing its origin, as it does, when occurring naturally, to inoculation with the poisoned secretion of an affected animal, and taking into view the facts that have been learned in connection with its transmission by artificial inoculation, evidence points to such in reality being the case. If due to a bacillus, why may not this bacillus be open to attenuation in the same manner as that of anthrax? If thus open to attenuation, why not susceptible of producing a non-fatal form of affection? And if this condition has been produced and passed through, why should not protection be thereby given against the subsequent development of the disease, as a result of the primary inoculation from the bite of the rabid animal?

Such a train of reasoning is quite legitimate, and for the application of the principle of action to which it leads, there is this advantage on the side of hydrophobia—that from the prolonged period usually taken for incubation after the introduction of the poison in the ordinary way, time is given for the artificial inoculations by subcutaneous injection to produce their effect and to render the system refractory to the further development of disease. I have been an eye-witness of Pasteur's work. It is from the nerve center, the seat from which the symptoms of the disease start, that he obtains his virus.

Employed for inoculation in a fresh state, it produces a fatal disease, and the disease has been transmitted successively on through a number of animals, with the result that the last affected animal yields as strong a virus as the first. Kept in a pure, dry air, attenuation advances, and after a certain time the nerve center loses its disease-producing power. Used for inoculation at a given period of preservation, it produces an effect which renders an animal resistant to the influence of inoculation with the virus in a fresh state, and Pasteur contends that it acts similarly when the virus has been introduced in the ordinary way. The treatment of persons bitten by rabid animals by inoculation with attenuated virus has now been on its trial a considerable time, and a large experience gained. Judgment, it must be stated, still stands in suspense; but it must also be said that the results obtained tell decidedly in favor of the view advanced. The other method by which it has been recently experimentally found that the virulence of bacilli can be weakened is by transmission through an animal of a different nature from that in which the disease naturally occurs. This, in reality, represents the principle at the foundation of the system of vaccination, discovered by Jenner at the close of the last century. It may now be regarded as an accepted conclusion that vaccine lymph is the virus of small-pox modified by transmission through the cow.

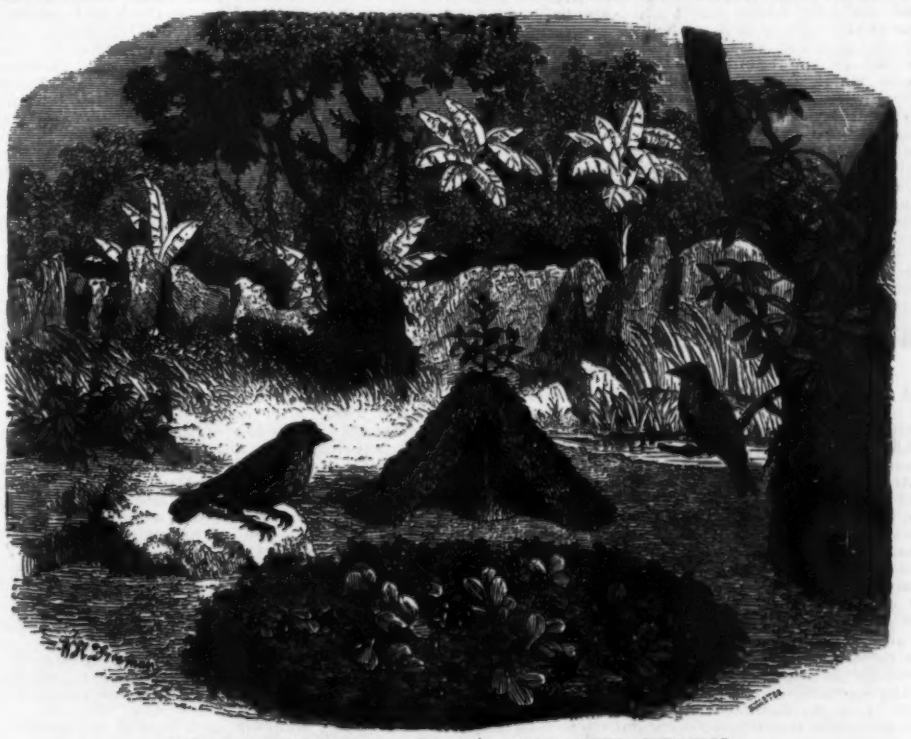
Jenner's discovery consisted in showing that the result of vaccination with the lymph of cow-pox affords as much protection against small-pox as an attack of small-pox itself. This was the fact he educed, but the knowledge possessed in his time did not permit of its being looked at in any further way than as a simple fact or truth of nature. Viewed, however, with the light that has been thrown upon it by the researches of the present day, we see not only the fact, but also its explanation. We see that the principle of action of the procedure proposed by Jenner, which has conferred such incalculable benefit upon mankind, is based upon the attenuating effect upon the small-pox virus of the human species by transmission through another animal; and knowing this, the prospect is presented of its being rendered susceptible of application for the control of other diseases.

Whether this should prove so or not, at all events advantage is gained by the knowledge acquired. Need I say anything more to exhort you, in accordance with the duty that has devolved upon me? Surely the acquirement of knowledge, giving us as it does greater power in the exercise of our calling, and thereby promoting the high and noble object of rendering our lives more useful to our fellow creatures—surely this is a sufficient incentive, following the words of Harvey, 'to search and study out the secrets of nature by way of experiment.'"

THE GARDENER BIRD OF NEW GUINEA.

THE efforts that have been made within a few years to penetrate to the interior of that mysterious land which, under the name of New Guinea, extends 1,200 miles to the north of Australia have been greatly rewarded.

The fauna of this part of the world—the ornithological fauna principally—is extraordinarily rich, and is now so well known that at the mention of the name of the island one's thoughts naturally revert to those birds of brilliant hues whose livery seems to be ornamented with all the gems of creation. Everybody has seen these without visiting the galleries of museums, for a barbarous fashion has converted their remains into an object of attire, and our fashionable ladies do not hesi-



THE GARDENER BIRD AND ITS WORK.

tate to encourage a massacre which, with certain species, amounts to destruction, in order to add a little brilliancy to their toilets.

New Guinea was discoverd in 1511 by Antoine Ambreu and Francois Serrano. Since then it has been visited at different times by navigators, and it may be said that all those whose names are celebrated have touched its coast. None of them, however, penetrated to the interior, owing to lack of time. It may be added that the natives have always exhibited great inhospitality, and that the bad reputation that they have obtained for themselves is in every respect justified.

Nevertheless, the few data reported by the observers and naturalists of various exploring expeditions were calculated to excite curiosity, and more than one savant burned with a desire to lift the veil that covered this *terra incognita*.

The last precise information dated back to 1841, and was gathered during the cruise made by Dumont Durville with the Astrolabe and Zelee. These shores were neglected for sixteen years, and it was not till 1867 that true explorations were begun, and it must be confessed that France, which had opened the way, was not represented in them. It is only in recent years that French scientists, such as Messrs. Laglaize, Raffray, and Maindron, have worked this new field, and enriched our collections with the magnficent species that are found there. It would be a very long task to give even a simple list of the discoveries of all these explorers. We shall cite only one at present, but one that is of so singular a character that we should be tempted to believe it to be an illusion, were it not confirmed by scientists of undoubted authority, especially by Mr. Bruijn de Ternate, Mr. Von Rosemberg, and Mr. Beccari.

In our climate, birds construct nests, which are admirably conceived for the future of their brood, and some of them, such as the smaller, are builders of the first rank; but their talent has always, and exclusively, a character of utility. If the nest is ornamented with

a few accessories, the only object of the latter is to hide it from the numerous enemies of the race, no sacrifice being made here for luxury.

A few years ago, a family of birds was discovered in Australia that build genuine pleasure houses for themselves. Like other birds, they have nests for rearing their future broods, but, along with these, they construct galleries on the ground out of twigs and small leaves, and here it is that the male courts the female, and that the young, before taking their flight, indulge in their sports. These little structures are not merely shelters, for their owners render them ornamental by the addition of shells, the bleached bones of small mammals, and brilliant pebbles that they collect at a distance.

New Guinea has a few representatives of this family, and one, among others, whose talents exceed all that the imagination could conceive of. It is the *Amblyornis inornata*. As its name indicates, this bird has not had bestowed upon it the brilliant plumage that distinguishes its kindred of Papua. It is of the size of the thrush, and of a dull russet brown color. Its claws and beak are strong, and ornithologists recognize in it certain affinities with the ravens.

But, although its person is not interesting, its actions are wonderful. It lives in the Arfalk Mountains, at an altitude of 4,400 feet. It is here that the above mentioned explorers met with it, and that one of them, Mr. Beccari, was enabled to study its work and habits close by. After selecting a very level spot where a straight-trunked shrub is growing, the *Amblyornis* surrounds the latter with a certain quantity of moss, so as to hide its base; then it brings a lot of twigs, and plants them all around, so that their upper extremity rests against the shrub in such a way as to form a conical cabin. Then it forms an aperture in the latter by separating two of the branches that compose it. For forming the walls, it selects an epiphytic plant that continues to vegetate for some time, and the leaves of which fill the interstices of the structure, and give a more pleasing aspect to the little hut.

This latter is 3 feet in diameter and 1½ feet in height. The entire surroundings of the cabin are cleaned, and the bird carries to a distance every twig, dead leaf, or stone that might obstruct the view. The bird does not stop here, but, in front of the door, forms a garden from perfectly clean moss, and ornaments it with flowers and fruit of brilliant colors—the rosy flowers of a *Vaccinium* and the violet fruit of a *Garcinia*. The interior of the cabin likewise receives ornaments, which, when withered, are rejected, and replaced by others, which the bird goes to a distance to collect.

The Malays call this bird the *Tukan-kobân*, "the gardener bird," and always respect its structures when they come across them. The Papuans assert that the fruit and flowers that ornament the work of the *Amblyornis* are presents that the male brings to the female at each of its visits. They call the bird *Burungura*, "master bird," a name justified not only by its architectural talent, but also because of its power of mocking the song and cries of other birds to perfection.

Like the other birds of its family, the *Amblyornis* builds a nest for its eggs near its little dwelling.—*Cosmos.*

THE LAKE OF TITICACA, SOUTH AMERICA.

By FREDERICK G. CORNING, M.E.

A JOURNAL of South American travel would hardly be complete without a chapter on the famous Lake of Titicaca, which is spread out over widely extended table lands, at a great elevation, in the heart of the Andes.

At this latitude, the boundary line between Bolivia and Peru, the Andes are divided into the Eastern and the Western Cordillera, between which ranges the great plateaux are expanded to the enormous width of about two hundred miles. This depression, hanging gracefully between the two Cordilleras, has an oval shape, and with an average width of one hundred miles, its area is about 15,000 square miles, forming one of the most remarkable terrestrial basins in the world. It appears to be of volcanic origin; blocks of lava are scattered along the shores of the lake, while igneous rocks are noticeable traversing the sedimentary strata.

The marvelous picturesqueness of the region, together with the signs of cultivation, furrowed plains, terraced hill-sides, and the numerous ancient relics of an historic civilization that are met with around the lake, upon arrival at Puno, on its western shore, are refreshing in contrast with the dreary railroad journey of over two hundred miles from Arequipa, Peru, through a desolate, silent, barren, ashy waste, where the tired traveler pants for breath in chilly altitudes, rising from 8,000 to 15,000 feet above the Pacific Ocean, in full view of the gray volcanic domes of Misti, Urvinas, and Chichani.

Titicaca is an Aymara word, and by some historians is translated cat-rock; according to other writers, *titi* signifies lead, and *caca* a chain of mountains. The exact elevation of the lake above the Pacific Ocean is given at 12,516 feet, according to railroad surveys made from Mollendo, on the coast, to Puno. With an area approximated at 2,500 geographical square miles, it is about 100 miles long, and averages 25 miles in width.

During the rainy season, from December to April, the lake rises about five feet; and during the dry season, when it sinks to the lowest level, the principal influx of water comes from the ranges of perpetual snow on the eastern shore. Of more than twenty different streams that flow into the basin, the main feeders are the Azangaro, the Maravillas, and the Ramis—the latter rising near the source of a tributary to the Ucayali.

The Titicaca is partially drained by the Rio Desaguadero, which is the only known outlet; and after pursuing a southerly course for, more or less, seventy-five leagues, the river spreads over the marshy flats of Pampas Aullagas, where the waters disappear through absorption and evaporation, there being no flow either toward the Atlantic or Pacific Ocean. The Indians believe the lake to be in subterranean connection, under the Cordillera, with the Pacific Ocean, because of the finding on the coast near Cobija of a certain kind of lake-rush peculiar to Titicaca, differing essentially from salt-water weeds.

Although the basin is gradually filling up from the masses of soil and sediment which are washed down its steep, barren banks, void of vegetation, tending to raise the water line, nevertheless the surface of the lake is slowly but surely sinking. The meteorological conditions are such that the evaporation during the dry season and the precipitation throughout the rainy months are no longer equipoised, and the area of the lake is, in consequence, steadily shrinking. As far back as three centuries, the sparkling waters of Titicaca dashed against the ancient monuments of Tiahuanaco, standing to-day twelve miles away from the shore, and at an elevation of 130 feet above the surface of the water. But still it is by far the largest lake in South America, being about half the size of Lake Ontario, and the largest on the globe at so great an altitude.

The scenery is not of that miniature type characteristic, for example, of the Koenig's See in Europe or of the Red Fish Lakes in Idaho; but the attractions of Titicaca consist in its vast expanse and magnificent Andean scale of nature's productions, combined with the poetry of prehistoric art. Looking across its crystal clear waters over into Bolivia to the east, the snow capped mountains of the Cordillera Real are seen rolling across the horizon like a succession of foamy waves—the loftiest mountains on the American continent. Here rise in majestic splendor the Nevado de Sorata and the Illimani, two groups of serrated snow peaks, fringed with glaciers, towering up to heights closely ap proaching 22,000 feet.

A scattering of beautiful islands is among the charms of this interesting sheet of fresh water. Of these, the island of Titicaca is full of historic associations and the home of many an Indian tradition. The narrow, winding passages formed by the islands and the main land, where the blue water is deep and transparent, together with the monolithic monuments and ruins sprinkled over this classic soil of the Incas, lend a fairy-like fascination to the scene.

The shores are dotted with the dingy, dusty huts of the Aymaras, whose past history is far more interesting than their present. Attired in somber garb, with a silent, sullen disposition, reflecting nature's condition at this altitude and latitude, this strange tribe moves about as if mourning their deterioration and fall from ancestral glories. They are indolent and poor; their occupation consisting in the cultivation of rice, potatoes, and barley. Along the shores of the shoaly coves, the Indians gather the lake rush, which they suck the juice from or make into salad. This rush, which grows about seven feet high, in places so thick as to appear like a meadow, is known as *totora*. In this bleak, mountainous region, where timber is unknown, its stalk takes the place of iron, wood, and canvas. Besides being used to make boats (*balsas*), mats, sails, houses, and beds, this bayonet-shaped rush, it is said, was formerly woven into bridges by the Incas and Aymaras, over which whole armies were passed. But now the Aymaras spend their time chiefly in attending the numerous feasts and religious exercises, a national characteristic, amid the jingling of church bells from dilapidated cathedral towers and the wild din of Indian music. The dances on these occasions are unique in their grotesqueness. To witness the droll reels at an Aymara *fiesta*, after suddenly awakening from meditations upon the grandeur of South American landscape, is to fall from the sublime to the ridiculous. On these carnival days, the Indians wear the most fantastic costumes, showing, however, a decided preference for bright colors. In appearance, they might be compared to a high order of scarecrows; and to see a procession of them rushing out of the church in wild confusion and rallying, with an image of their patron saint, for a grand *finale*, after a day of intoxicating revelry, is to be forcibly reminded of an insane asylum let loose. The favorite sport consists of a kind of tournament, in imitation of a Spanish bull fight, that is carried on for hours at a time in all possible phases. They equip themselves with the heads, horns, and hides of cows, which are to be had at Puno, and, after drying them in the sun, they are suspended by their belts, and then, probably for propriety's sake, the animal is clad in skirts that hang modestly to the ground. Some play the *toros*, while others impersonate the *toreros* and *matadores*, and the whole population turns out on the *plaza* to pay homage to the celebration. Throughout the greater part of these exercises, the Indians, old and young, are very grave and serious. A funereal solemnity reigns supreme, and no revelry is indulged in until they become too intoxicated to follow the leading chief in proper order.

The dress, manners, and general appearance of the Aymaras are about the same as those of the Quichua tribe. The women, however, are more thickly set, better looking, and apparently in a more cheerful frame of mind than the Quichuas.

Altogether, the lake region is healthy, and there appears to be but very little sickness. As night draws on, the cool winds sweep rapidly through the gorges and ravines of the great mountain ranges, oftentimes with the speed of a whirlwind, running the dust up into columns of immense height, and drawing up the water from the surface of the white-capped lake in spouts almost equally high.

At Puno, a Peruvian city of 5,000 inhabitants, the nights are often bitterly cold; and as llama dung and *tola*, a variety of moss, are the only fuels in the land, the luxury of warm hearths is unknown. Early in the evening, the people wrap themselves in shawls and cloaks, or go to bed for comfort. The region adjacent to Titicaca supports a population of more than one million. Puno, the largest town, is mostly inhabited by Aymaras, although there are a few Quichuas who form a set by themselves. The city owes its origin to the silver mines of Cancharani, in the neighboring hills, which are now comparatively abandoned, although claimed by some not to be exhausted. All the dwelling houses are built of adobe, and are very low and uncomfortable; but the city boasts of a cathedral that dates back to 1757, a university (so called), and several schools. It is the central point for the alpaca industry, coca is also largely traded in, while sheep's wool and vicuna robes are among the chief exports.

The lake, which is the natural highway between Peru and Bolivia, is navigated by two small 100-ton steamers, which were transported from the coast over the mountains in sections, under great difficulties and at an expense far exceeding their cost. Steam is got up with llama dung as the sole fuel, and the trip across to Chililaya, in Bolivia, is made in about twenty hours.

Among the intermediate places of exceptional interest, at which the steamer touches during this memorable passage, the church of Copacabana deserves especial notice. This quaint old church of semi-cathedral, semi-monastic appearance is to this section of South America, in reputation and ecclesiastical importance, what Notre Dame is to France. It contains the famous *milagrosisima virgencita*, or little miraculous virgin, and, although the edifice has no definite style of architecture, but in detail is a combination of Doric, Corinthian, and Spanish Renaissance, it is nevertheless graceful and most picturesquely situated. Its high walls inclose a rare collection of precious jewels and choice gifts, valued at many millions, which have been offered up as grateful tributes to the supernatural powers and astounding miracles of the Virgin. At stated periods, great multitudes come from all parts of Bolivia, and assemble before the sacred shrines of Capacabana, to supplicate spiritual and, not unlikely, material blessings. It is a strange fact, but none the less true, that the most acceptable and favored prayers are said to be those of the women imploring deliverance from sterility; for it is well known that in these elevated barren regions and in this rarefied atmosphere of the Andes, people do not multiply in anything like the same proportion as the population of the deep, fertile valleys, surrounded by a greater amount of vegetable life and a more normal atmospheric pressure. And it is the ability to happily reverse this natural law that is claimed as the immaculate accomplishment of the *milagrosisima virgencita*. It has been irreverently suggested, however, by modern scientists of deep penetration, that the credit of effectually alleviating this affection is possibly more justly due to the altogether terrestrial supplications of the priesthood of Capacabana than to the more celestial influences of the *virgencita!*

The environs of this romantic and religious spot are strewn with the art relics of imperial Inca glories. These architectural and sculptural relics on the borders of Lake Titicaca are frequently cited by scholars as representative examples of what is called prehistoric art, by which we understand all art forms irrespective of chronological order, that show human faculty at its best in this domain, before it has been touched by civilization. The extinct tribes that once inhabited this wild region have left to the world a museum of most interesting relics in this important field of knowledge, whose lights are few and dim. Indeed, according to Humboldt and others, these innumerable abandoned towns, gigantic monuments, remnants of public works, and scattered cemeteries indicate that the basin of Titicaca was once the seat of probably the highest and most ancient civilization on the South American continent, whose vast population, forming an empire greater than that of Charlemagne, swarmed over the land, and has left behind in these stone remains of hoariest antiquity the evidences of superior power and skill.

According to tradition, the region of Titicaca was not only the home of the Inca race, but also of the great Peruvian law-giver, Manco Capac, who diffused his influence throughout the land. An appreciation of the remoteness of this era may be had when it is remembered that the ancient Peruvians had only the vaguest ideas concerning the ruined edifices of Titicaca; and furthermore, that the eminence supporting the ruins of Tiahuanaco, to-day twelve miles from the lake and considerably over 100 feet above its surface, was formerly a beautiful island in the midst of deep water. This fact, coming so nearly within the historical period, and on that account of unusual geological interest, warrants the belief that the art relics of Titicaca antedate all others known on the American continent. Authorities hold that the ruins of this desert island bear the same relation to the aboriginal monuments of South America as do those of Palenque to the old remains of the Central and North American continent. They indicate a much higher order of artistic attainment than existed anywhere in South America at the time of the Spanish conquests. They tell us the story of brave races of men struggling after higher conditions; and their weird forms stand in the wilderness like the skeletons of prophets who looked far down the track of the centuries and foretold a better time. They are indeed achievements of intellect worthy to be commemorated in history.—*Eng. and Mining Journal.*

TOBACCO CULTIVATION IN ENGLAND.

FOR half a century nearly, our illustrations given of current events have never included among the products of an English harvest a crop of tobacco. It was reserved for 1886 to see the plant cultivated and dried in Great Britain as a farm crop. The pictures given are not fancy sketches by an artist, but copies of real things, engraved from photographs taken by Mr. Goodhew, Barnsbury, London, on the lands of the High Sheriff of Kent, Mr. Faunce De Laune, of Sharsted Court, near Sittingbourne. They represent in reality a farm crop; for if at present the several experiments allowed by Government have not exceeded an acre in any case, yet such a scale has been ample for the purpose, and tobacco cultivation has been lifted above mere garden trials, and raised to the rank of practical agriculture. Nothing succeeds like success; and the projected experiments advocated by a Kentish Peer and a Norfolk Baronet last spring in Parliament, which were sanctioned by the Liberal Government, but which the Royal Agricultural Society of England declined to support, have been successfully carried out, and are now petted by public favor. Like many other things, the English climate has proved not so bad as report made it. What was said to be impossible, the rearing and maturing of the tobacco plant in England, has been accomplished; and this season's results are thought as not unlikely to be the beginning of a new and great industry in the United Kingdom.

The history of the movement may be briefly given. About a year ago, Mr. De Laune, at an agricultural meeting, when reviewing the existing depression of farming interests, suggested, from what he had seen abroad, that tobacco might be added to the list of the crops of this country, and give employment to great numbers of women and children, who find occupation in attending the growth and manufacture of the plant. Inducing his neighbor, Lord Harris, to take up the subject, and introduce it to legislative notice, Mr. De Laune found the idea take firm root in the public mind, and Sir Edward Birkbeck and others had good words to say in favor of an attempt being made. The Revenue Department, while seeing a source of national income to the amount of eight millions to nine millions

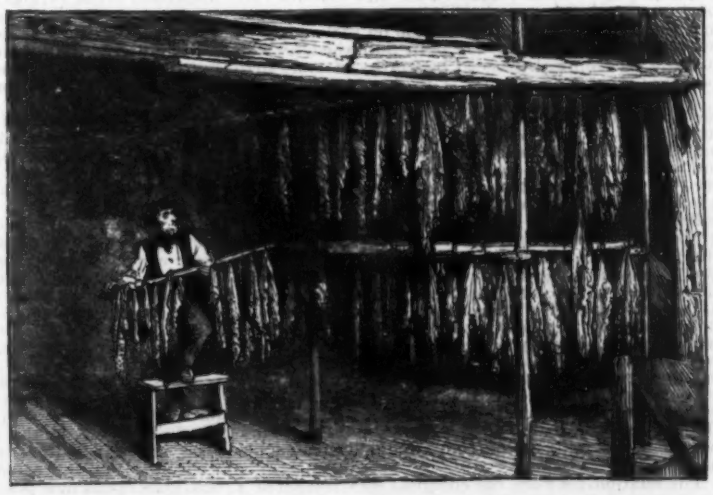
sterling involved in the subject, yet showed no hostility; and the Government agreed that, under such auspices as the Royal Agricultural Society, the experiment might be allowed.

But the season was advancing, and, to the disappointment of Lord Harris and many others, the Agricultural Society came to the conclusion, through its Council, that "it was too late to commence the experiment this year, but would be prepared next year to provide the necessary skilled supervision, if the Treasury would defray the expenses." At this date in April further action seemed likely to be restricted to the Royal Horticultural Society growing a quarter of an acre, at the request of Lord Harris, when Lord Walsingham, as president, Mr. Kains-Jackson, as honorary secretary of

STAGING THE TOBACCO LEAF.

CARTING THE CROP TO THE OAST HOUSE FOR DRYING.

PICKING THE TOBACCO LEAF.



HANGING UP THE LEAF TO DRY.

A FIELD OF TOBACCO PLANTS, SHARSTED COURT, KENT.

TOBACCO GROWING IN KENT, ENGLAND.

the Ensilage Society, made application to Sir Algernon West, chairman of the Inland Revenue Department, and on April 10 promptly received an answer that "acting under instructions from the Lords of the Treasury, the Board of Inland Revenue will be happy to grant permission to certain agriculturists, to be named by the Ensilage Society, to make experiments in the growth of tobacco, provided they comply with the regulations laid down in the inclosed memorandum."

Toward the end of September, and during the present month, the cutting of the plant has taken place, and various attempts are now being made to dry and cure the leaves, so that they shall become good smoking tobacco for pipes, cigars, or cigarettes. The writer has made and enjoyed the smoking of several green cigarettes; but it is too early to say what will be the quality of the yellow and brown leaves that are drying in cool barns, or that, as in the case of our illustration, have been dried over the fires of an oast house. At this moment some fine leaves are being cured in the pure hot air chambers of the Turkish baths near the Grosvenor Hotel, having been placed there by the honorary secretary of the Ensilage Society; and further the novel attempt is being made of placing the half dried tobacco leaves in the model of a silo, which some chemists have suggested would preserve and ripen the tobacco successfully. Generally, the measure of success that will attend all these experiments can only be proved by time; but that English soil and climate will produce finely developed plants is shown by our illustrations.—*Illustrated London News.*

PROF. ABBE'S NEW OPTICAL GLASS.

EVERYTHING that falls from the pen of Prof. Abbe, of Jena, relating to optical matters commands respect. His announcement, therefore, of the discovery of new kinds of glass, specially adapted for the manufacture of lenses, has been received with peculiar interest, and although details of information on various points are still wanting, enough has been published respecting the new optical glass to be worthy of more than passing notice.

All who have had anything to do with optical instrument making know only too well the existence of the defect termed "irrationality of dispersion." When Hall and Dolland had independently shown that the chromatic dispersion of a crown glass lens might be corrected by combining it with a second lens of flint glass, a new impetus was given to optical research. The so-called "achromatic" lens in the hands of successive generations of opticians constituted the basis both of the modern microscope and of the modern telescope. But as greater and greater perfection in the construction of the "achromatic" lens was attained, it became apparent that perfect achromaticity was very far from being realized; for though two lenses might be found which should perfectly bring together two widely differing rays, such, for example, as the red of the line C of the spectrum and the blue of the line G of the spectrum, it by no means followed that this pair of lenses would bring together to the same focus all other rays. On the contrary, owing to the "irrationality" of dispersion, a "secondary spectrum" would always remain uncorrected.

The relation between the chemical constitution of a medium and its action on waves of light of different periods is one of those matters about which we are still profoundly ignorant. We know that a prism of glass does not spread out the waves in proportion to their wave length or to the frequency of their periods. A simple case of irrationality is afforded in the fact that a green ray which, when viewed through one prism, may lie exactly half way between C and G in the spectrum, will not lie exactly half way when viewed through a prism of a different kind of glass.

All that a combination of two lenses can do is to achromatize for two rays of the spectrum; it may very nearly achromatize for the neighboring rays, but, strictly speaking, it only achromatizes for two. For ordinary optical purposes, we seek to achromatize for the red and the blue, so reconciling the end regions of the visible spectrum. For photographic purposes we achromatize for green and violet (or even ultra-violet) rays, reconciling the end regions of the photographically active spectrum.

To Dr. Blair, whose observations were published in the *Transactions* of the Royal Society of Edinburgh for 1791, we owe the suggestion to achromatize for three rays by using compound lenses of three different media. Blair, indeed, made a most extensive examination into the dispersive powers of various media, and in particular of liquid media, which he proposed to use in his compound lenses, a fluid lens being formed in a cavity between two lenses of glass. He also suggested combinations of two or more fluid lenses. He found that in the spectrum of hydrochloric acid the green rays lay much nearer the violet than in the spectra of most metallic solutions, and he proposed to use the chlorides of antimony and of mercury in various proportions along with hydrochloric acid, or with sal-ammoniac, in order to obtain a fluid which, while having a different absolute dispersion from crown glass, should have its relative dispersion or relative distribution of the rays of different colors proportionately identical throughout the spectrum. Blair's object glasses for telescopes, though regarded at the time as of singular merit, never came into use. The only recent serious attempt to revive a triple lens, for approximating to a correction of the secondary spectrum by achromatizing for three rays, has been that of Prof. C. S. Hastings, of Yale, who has used three kinds of glass.

What Blair proposed to effect with his liquid combinations Prof. Abbe claims to have now achieved by his discovery of new kinds of optical glass. To Abbe we owe the remark that, in addition to the secondary chromatic aberration of our so-called achromatic lenses, there exists a second defect, termed by him the chromatic difference of the spherical aberrations. This term he uses to denote the fact that with the crown and flint glasses used by opticians, though the curves of the lenses be calculated to correct the spherical aberration, taking in each case the mean refractive power, there will be a slight residual spherical aberration for all rays not of mean refractive index, the lens being spherically under-corrected for red rays and spherically over-corrected for blue.

Having realized, so far back as 1880, that these defects were inherent in the use of such glass as opticians had at their disposal, Abbe determined to make a resolute attempt to discover new kinds of glass which should be free from these vices. The research involved no less a field of work than the examination of the optical properties of all known chemical substances which undergo vitreous fusion and solidify in non-crystalline transparent masses, together with a detailed comparison of their physical and chemical properties. The work was begun so far back as January of the year 1881 by Prof. Abbe and his coadjutor, Dr. Schott, then of Witten in Westphalia, now of Jena.

Dr Schott undertook the chemical portion and the melting processes. Prof. Abbe and his assistant, Dr. Riedel, conducted the optical examinations of the products. At first only small quantities, from 20 to 60 grammes in weight, were melted at once, all kinds of chemical elements being tried with the view of ascertaining their influence on the refractive and dispersive powers.

Not only were glasses of ordinary kinds having silicic acid for their chief constituent tried, but also glasses, resembling Faraday's famous "heavy glass," made from boric acid and also phosphoric acid. So, by the end of 1881, a series of fundamental facts in chemical optics were gathered together for future use. The next point was to use these chemical researches as the basis for the production of real glass possessing the necessary qualities of hardness, colorlessness, and unalterability.

To carry out this work, Dr. Schott moved to Jena early in 1882, and set up a special laboratory for scientific glass making, with proper blast furnaces, and smelting pots in which quantities of 10 kilogrammes could be melted at once. Until the end of the year 1883 this research laboratory was occupied almost exclusively in working toward the solution of two practical problems. The first of these was the production of pairs of kinds of flint and crown glass, such that the dispersion in the various regions of the spectrum should be, for each pair, as nearly as possible proportional. The object of this was to permit of a higher degree of achromaticity than hitherto possible, by diminishing the secondary coloring effects inseparable from the irrationality of the ordinary silicate flint and crown glasses.

The second problem was the production of a greater multiplicity in the gradations of optical glass i respect of the two chief optical constants, the index of refraction and the mean dispersion. Though this has not generally been regarded as an important need in optics, it was considered by Prof. Abbe and Dr. Schott as of quite equal importance to the first. For the silica glasses hitherto used constitute, according to their composition, a simple series, from the lightest crown to the densest flint, in which, with an increase in refractive index, there is practically always an increase in the mean dispersion.

But there is no doubt that for many purposes of practical optical instrument making, particularly in the designing of optical combinations for special purposes, it would be a great benefit for the optician to have at his command other kinds of glass in which the refraction and dispersion are not related in the way in which they are in the silica glasses; for example, a glass having great refraction and small dispersion. Hence the multiplication in the available kinds of optical glass opens new possibilities of great practical moment.

Pending the publication of these very valuable scientific investigations, only a very brief account can be given of the actual results. The first problem has been satisfactorily solved, with the result that achromatic lenses of a much more perfect kind than has ever been attainable are now in the market; and the second has also been successfully carried out, a whole series of new glasses of graduated properties having been introduced into the optical trade.

Down to the autumn of 1883 the matter was one of systematic scientific research; but at that date, encouraged by the substantial fruit borne by the investigations, a further step was taken. In conjunction with the brothers Dr. Carl Zeiss and Dr. Rod. Zeiss, of Jena, whose names are household words to every microscopist, a commercial enterprise was set on foot for establishing a new glass foundry. This establishment, which, under the style of Schott & Co., has been at work since the autumn of 1884, produces glass of all kinds, old and new, on a large scale. The first application of the new glass to the microscope comes naturally from the famous firm of Zeiss. To his new microscope lenses Prof. Abbe gives the distinctive name of *apochromatic objectives.*

He claims for them great superiority in the finer qualities of definition, the new dry apochromatic lens giving an image equal to that of an ordinary achromatic water immersion objective. He also claims that the more perfect corrections permit equal magnification to be obtained by using a longer focus objective with an eye-piece of higher power than hitherto has been usual, thus obviating some of the difficulties of very short focus objectives. Moreover, the foci for visible and for photographic purposes are identical. Special compensating eye-pieces have been also devised for use with the new apochromatic objectives.

Whether these new appliances are found to fulfill under the test of experience all that their inventor claims for them remains yet to be seen; but it cannot be doubted that a great step has been taken. It ought also to be recorded to the credit of all concerned that no attempt is being made to secure to one firm a monopoly of the new materials, but that the new optical glass is offered to the optical trade without any restriction or patent to stand in the way of further development.

Nor less honorable or significant is it that the researches of the "Glass-technical Laboratory" of Jena should have been supported by a very liberal and several times repeated subvention from the Prussian government. Such a result arising from the endowment of research makes ample answer to the easily uttered assertion that such endowments, if given, would be wasted on useless fancies and trifling schemes. We sincerely congratulate Prof. Abbe and Dr. Schott on the completion of their most meritorious labors.—*Nature.*

A HOE for use in a garden requires as much care as a scythe that is used for cutting grass. It should be sharp enough to cut off the roots of all kinds of weeds, and should have so good a polish that it can be moved through the soil without much exhibition of strength.

SAND BAG FOR APPLYING HEAT TO THE BODY.

A SAND bag is recommended as a convenient article for applying heat to the body in case of sickness. Get some clean, fine sand, dry it thoroughly in a kettle on the stove; make a bag about eight inches square, of flannel; fill it with dry sand, sew the opening carefully together, and cover the bag with cotton or linen. This will prevent the sand from sifting out, and will also enable you to heat the bag quickly by placing it in the oven or even on top of the stove. After once using this you will never again attempt to warm the feet or hands of a sick person with a bottle of hot water or a brick. The sand holds the heat a long time, and the bag can be tucked up to the back without hurting the invalid. It is a good plan to make two or three of the bags and keep them on hand, ready for use at any time when needed.

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